UNIVERSIDAD POLITECNICA DE VALENCIA

USE OF ELECTRONIC SENSES IN FOOD CONTROL AND ANALYSIS

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Departamento de Tecnología de Alimentos

FRONTERAS EN LA TECNOLOGÍA DE ALIMENTOS

Sensores y nuevos métodos de detección aplicados a la industria alimentaria

Benasque, 5-9 de Julio 2010

INTEREST FOR DEVELOPING ELECTRONIC SENSES

- Automatic control and measurements → Reduction of Labour → Cost reduction and more stable processes.

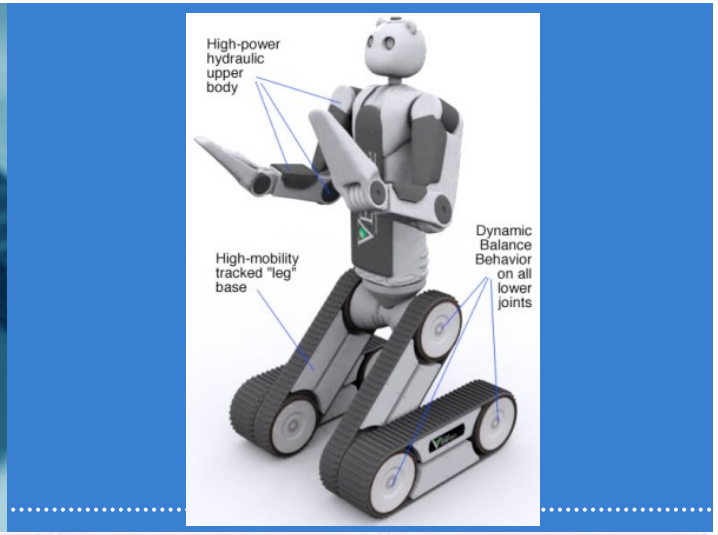
- Reduction of time between measurement and results → Reduction of the action time

ASSURE THE FOOD SAFETY

IMPROVE COMPETITIVINESS

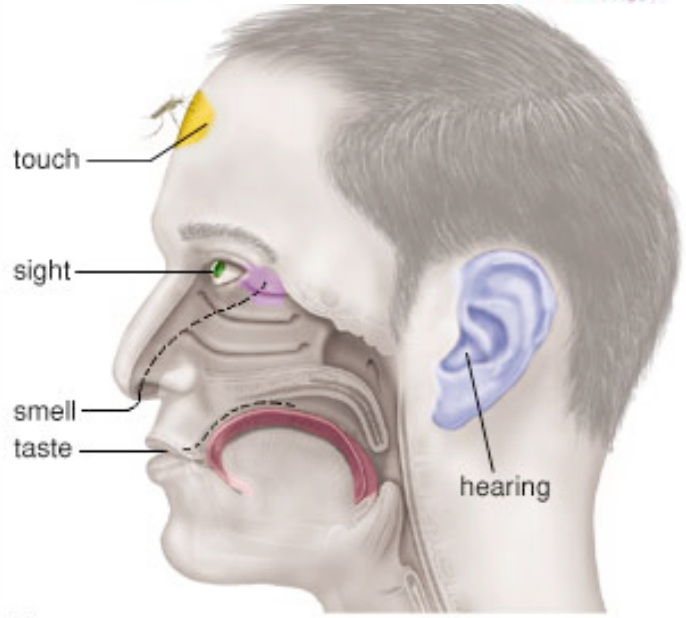
- THE FINAL GOAL: ONLINE measurements of ALL food products at EVERY POINT of the food chain

http://www.rtve.es/television/20100406/sensores---tres14/328377.shtml


High-power hydraulic upper body
High-mobility tracked "leg" base
Dynamic Balance Behavior on all lower joints

INDEX


Flavour


touch
sight
smell
taste
hearing
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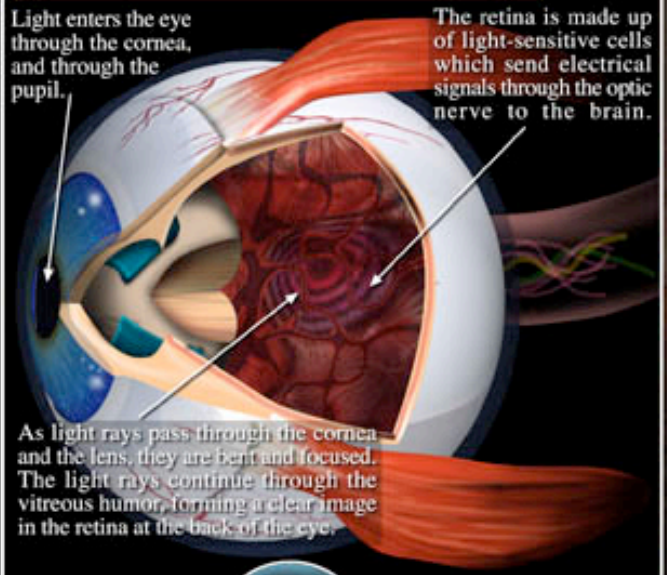
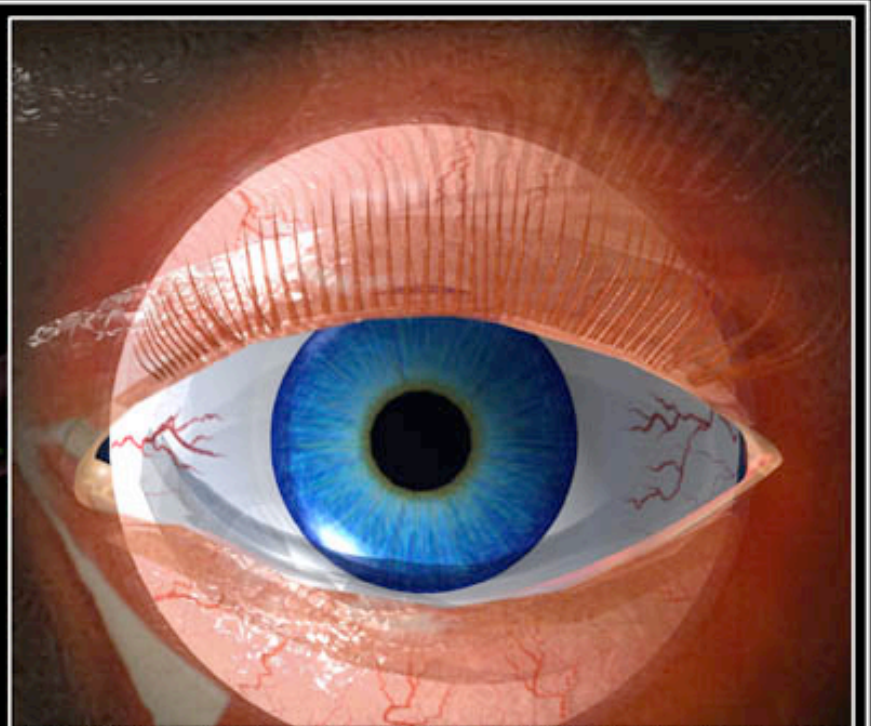
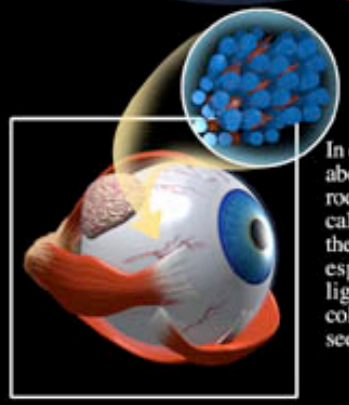
the 5 senses
sight
Our eyes let us see things around us.
hearing
We use our ears to hear sounds.
touch
We can feel things with our hands or with other parts of our bodies.
taste
We taste things with our tongue. We can taste lots of different flavours.
smell
We smell things using our nose.

THE 5 Senses SIGHT

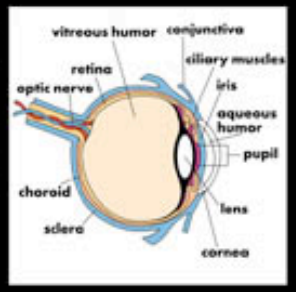


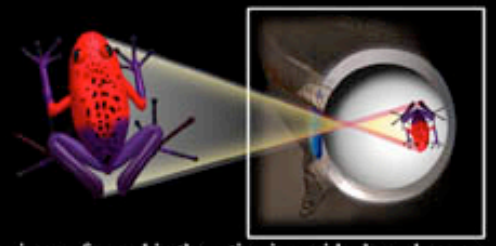


Sight is our dominant sense. About 70% of the body's sense receptors are packed into the eyes. Every second, these receptors send millions of nerve signals to the brain. Vision is estimated to occupy more than one-third of our total sensory awareness, and is the source of more than half of the information in the brain.



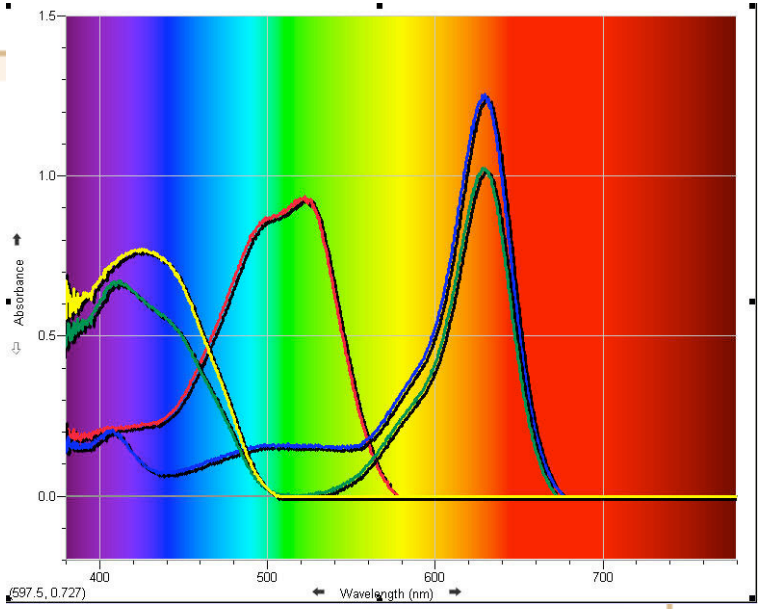
In each eye, the retina contains about 125 million cells called rods and about 6 million cells called cones. The rods detect the brightness of light, and are especially effective in dim light. The cones detect the color of light, and allow us to see fine detail.



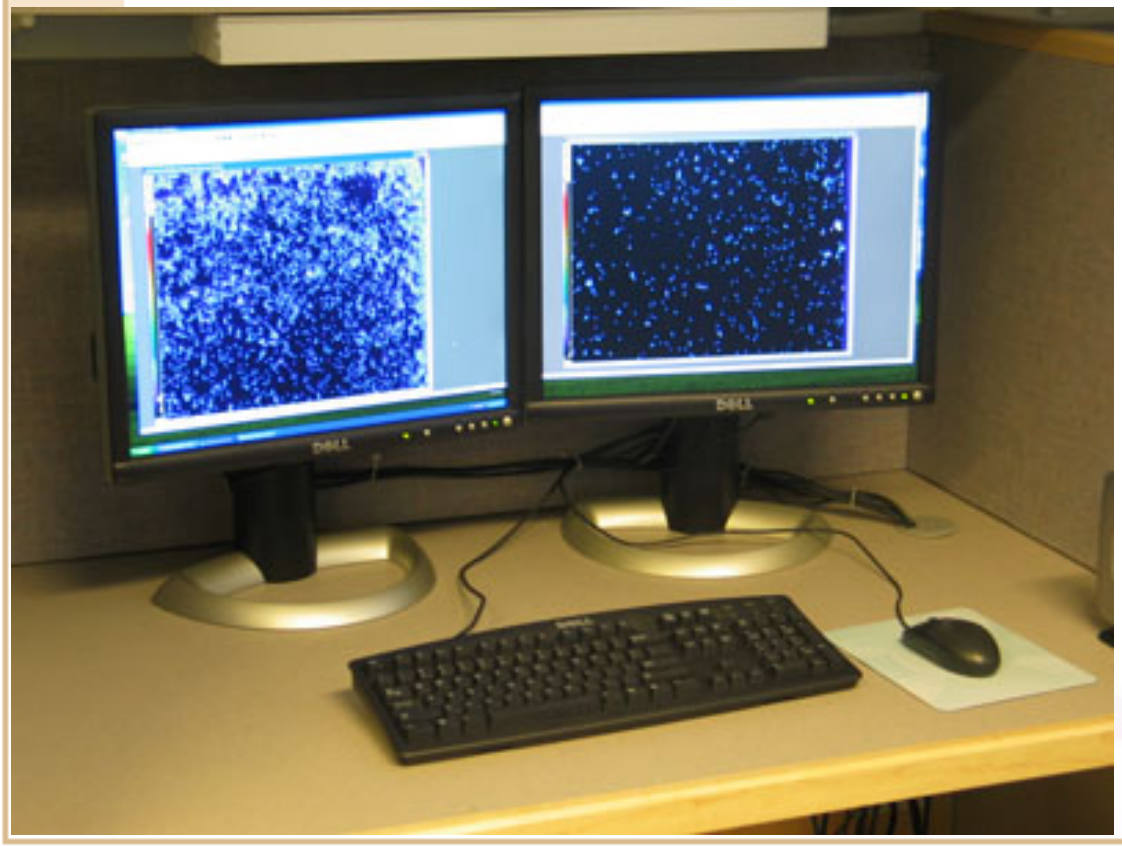


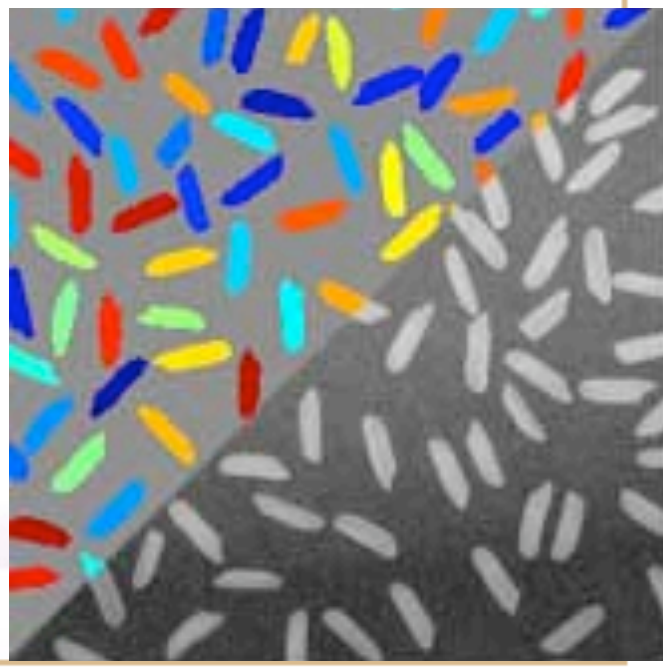
The image formed in the retina is upside down because of the way the lens inverts light rays. The image is automatically turned right side up in the brain.

IMAGE ANALYSIS



Spectral Analysis of Food Dyes

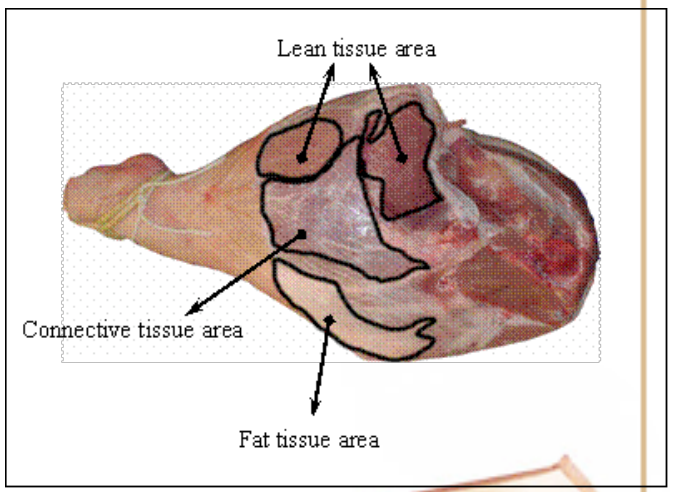


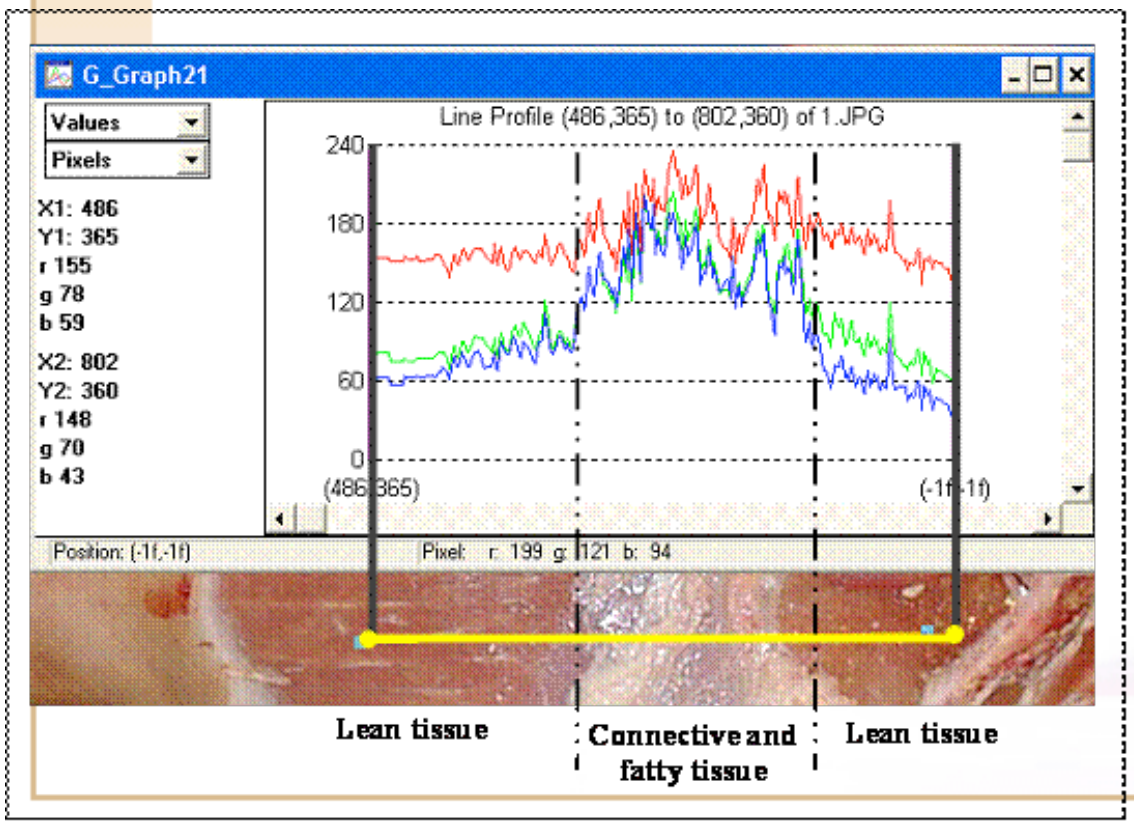


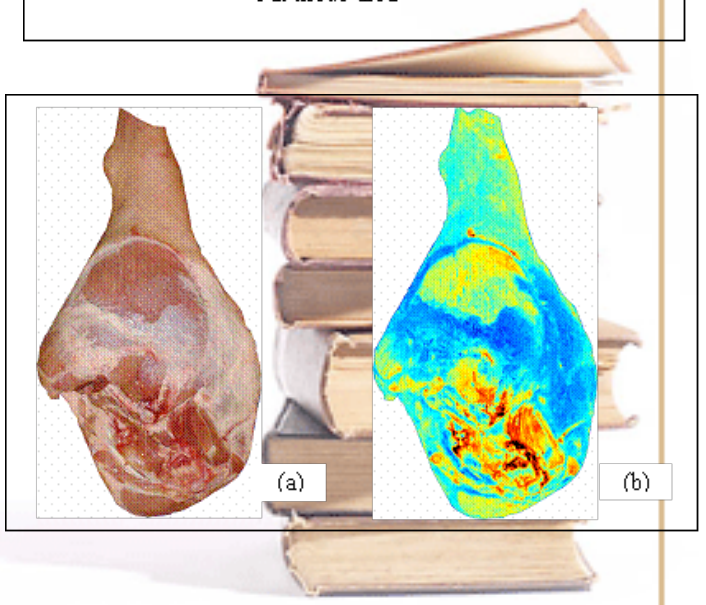
Analysis of visible Image

- Measurement of surface areas of ham

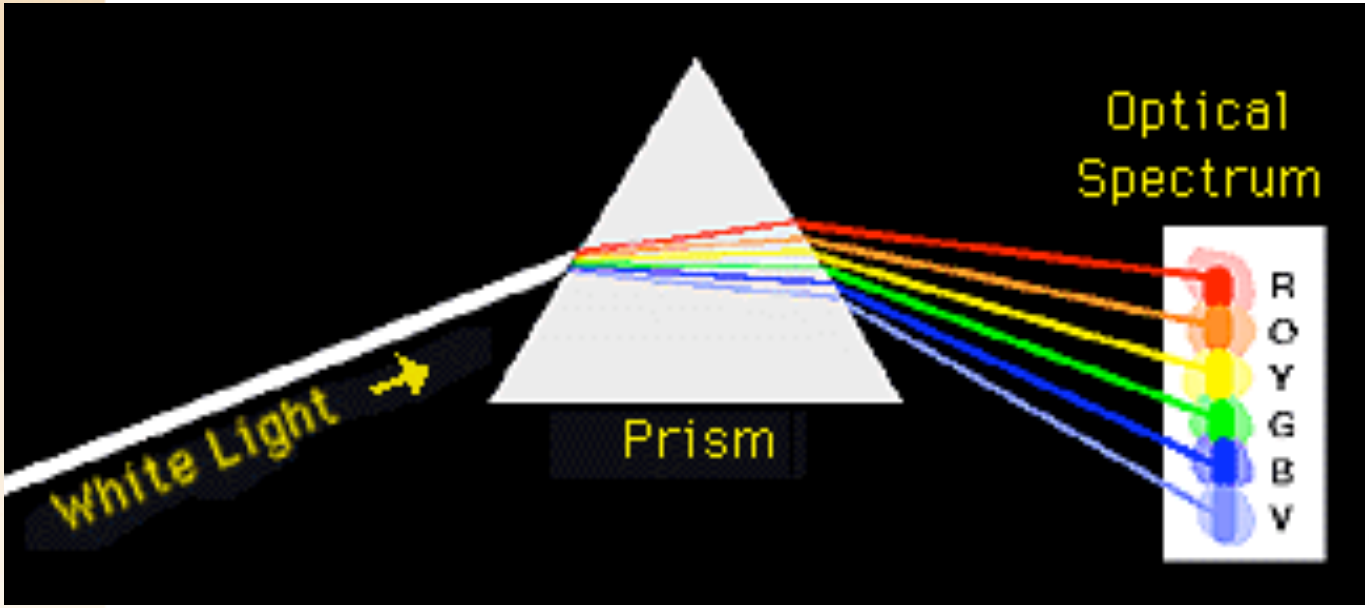
Sánchez-Salmerón A.J.; Albarracin W.; Grau R.; **Barat J.M.**; Ricolfe C. (2007) Control of ham salting by using image segmentation. **Food Control**. **19:135-142**.

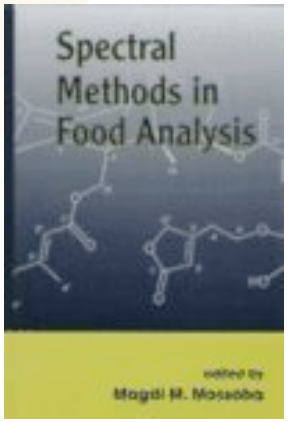






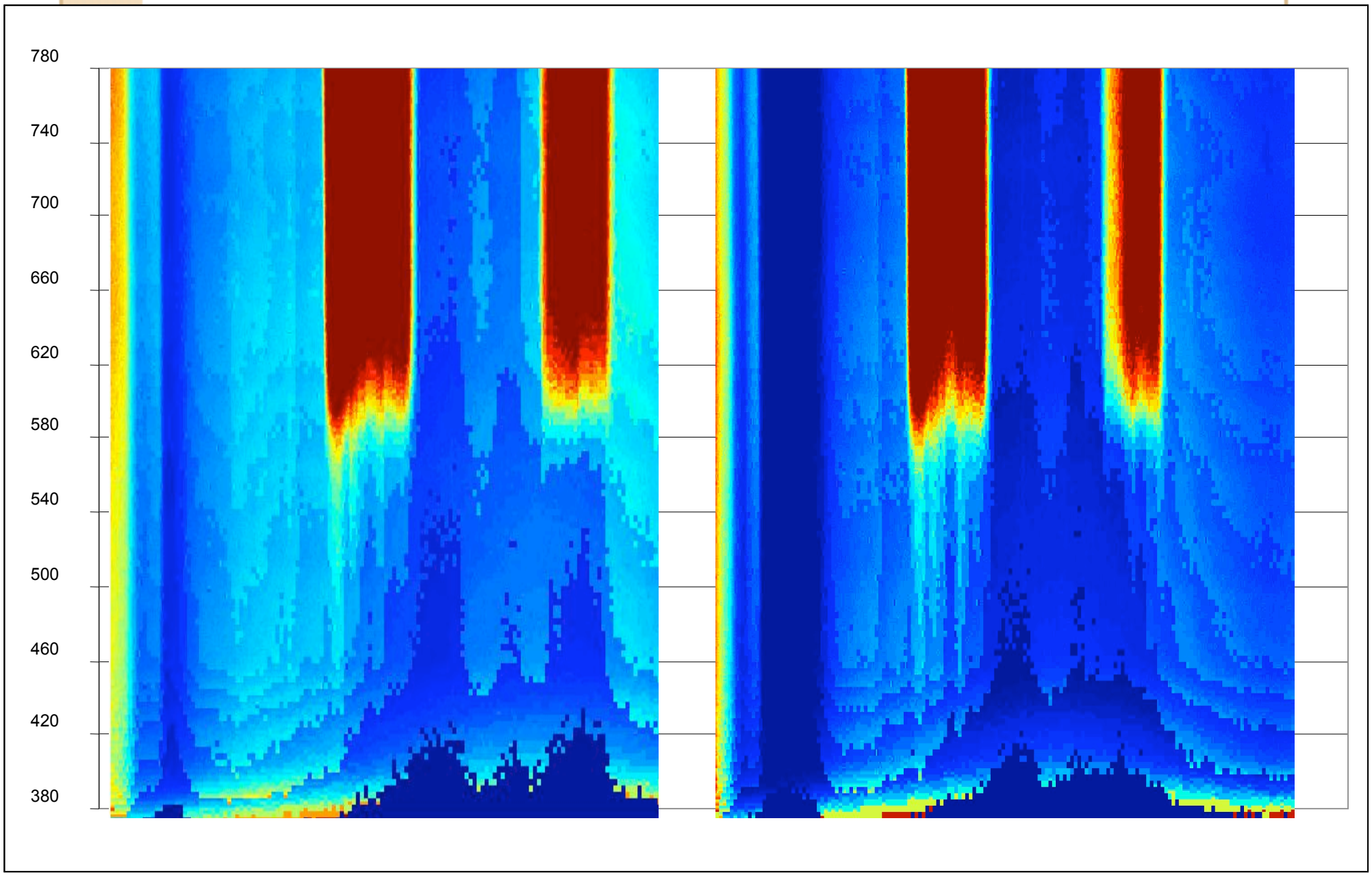
Spectral analysis

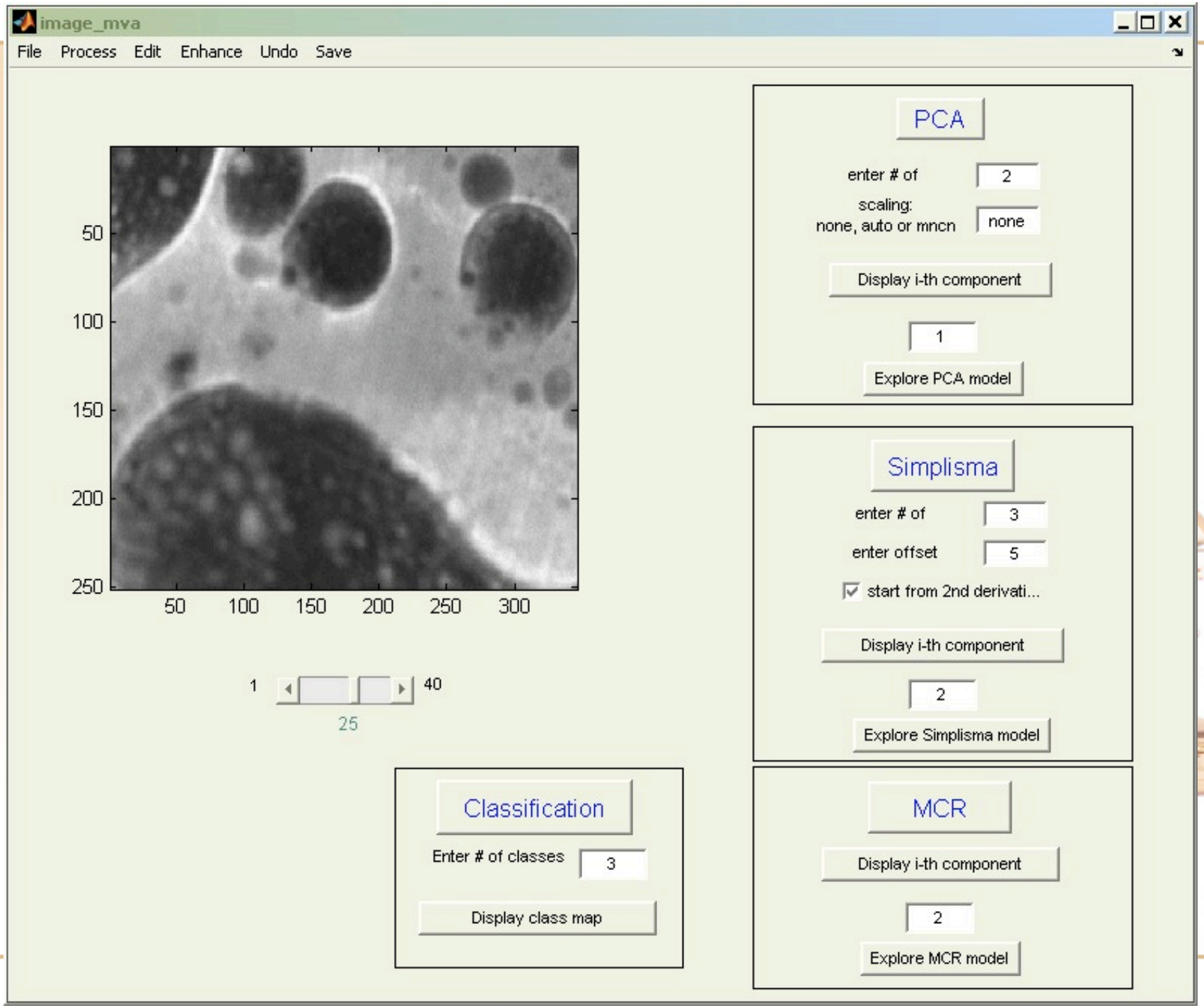


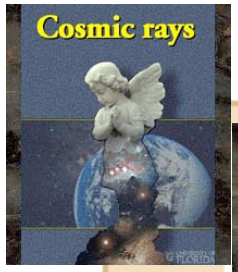


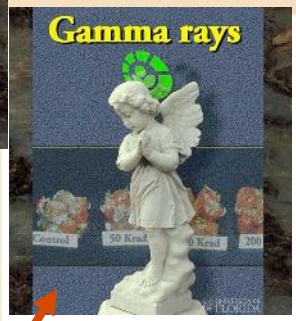
Sliced carrots

Day 0 Line 10 Day 6

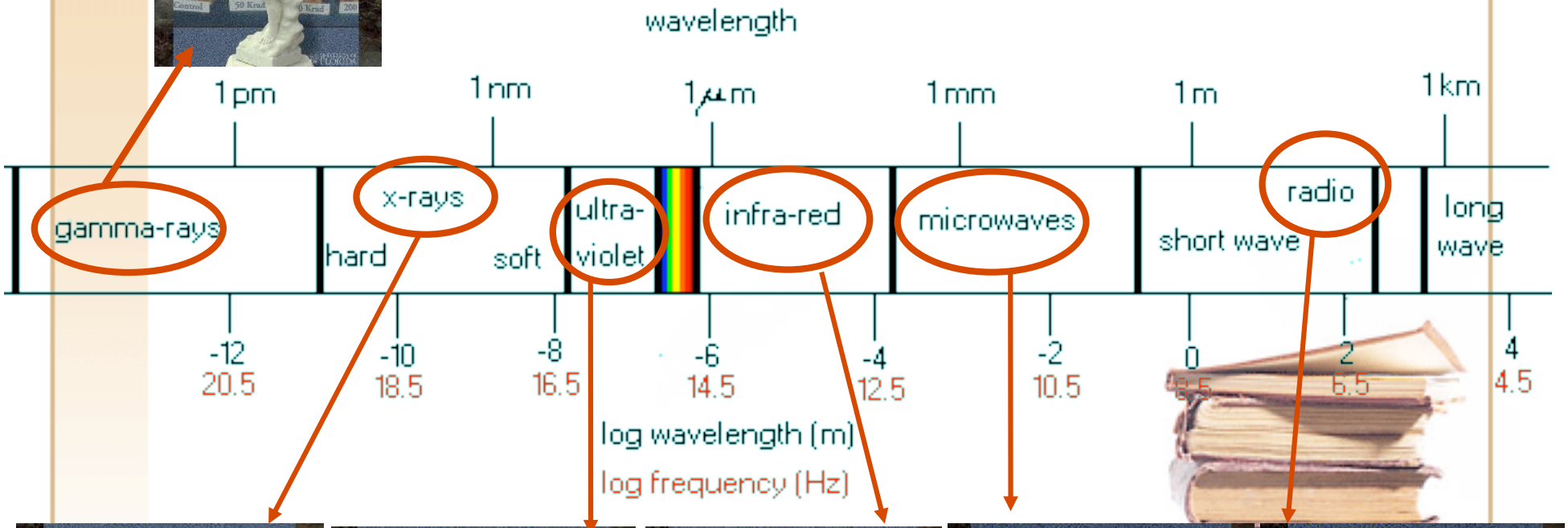


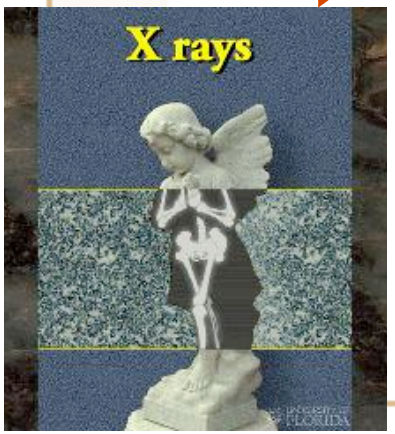

image_mva
File
Process
Edit
Enhance
Undo
Save
50
100
150
200
250
50
100
150
200
250
300
1
40
25
PCA
enter # of
2
scaling:
none, auto or mncn
none
Display i-th component
1
Explore PCA model
Simplisma
enter # of
3
enter offset
5
start from 2nd derivati...
Display i-th component
2
Explore Simplisma model
Classification
Enter # of classes
3
Display class map
MCR
Display i-th component
2
Explore MCR model

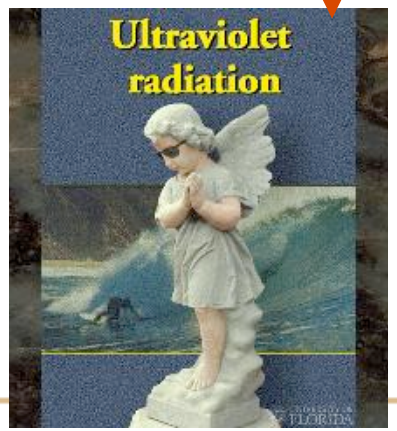


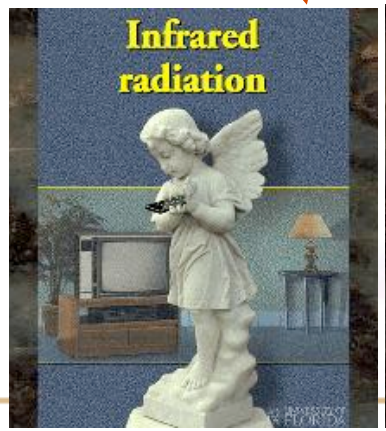


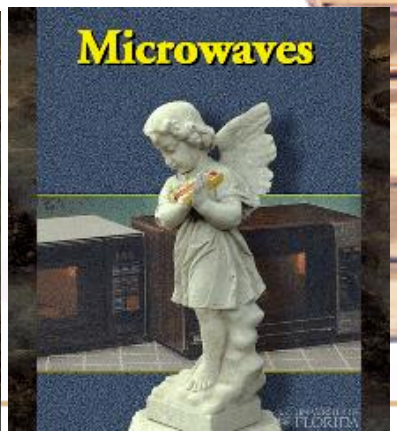
THE WAVELENGTH RANGE











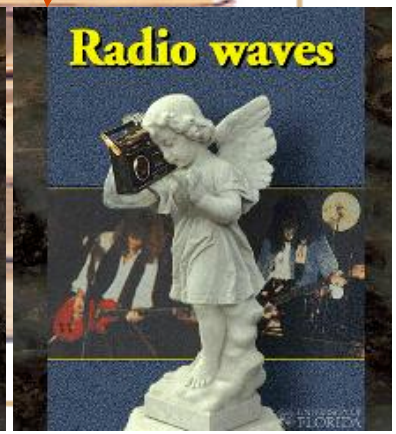
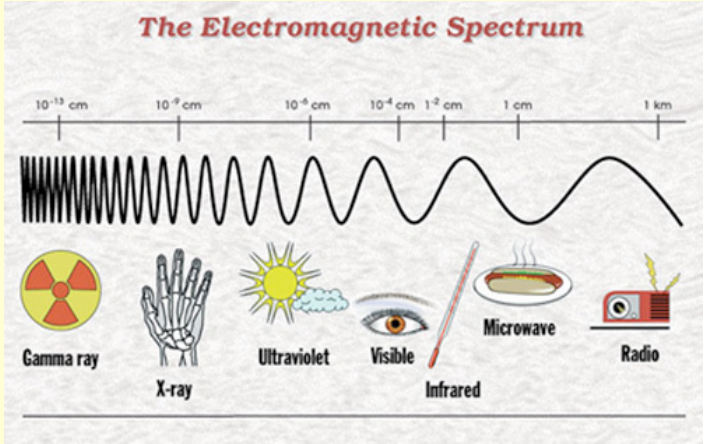


IMAGE ANALYSIS TECHNIQUES

Electromagnetic waves

- X-Ray - Computed tomography
- Visible Image analysis.
- NIR
- Microwaves –300 MHz – 300GHz – wave length: 1m – 1mm
- MRI (study of induced atomic resonance by means of a magnetic field)



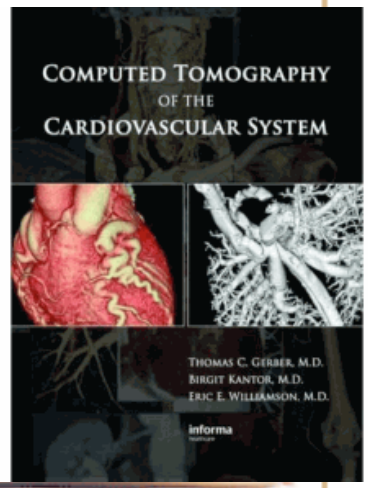
Acoustic Waves

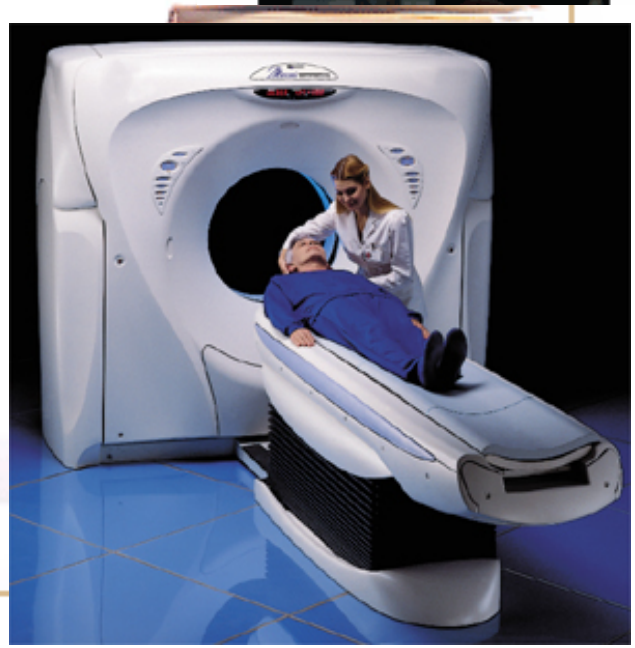
- Ultrasounds
  - >20.000 Hz

X-Rays
COMPUTED TOMOGRAPHY

- Use of X-Rays
- Detects changes in density

- X rays consist of electromagnetic radiation (like light), but with a shorter wavelength, that penetrates the body and forms an image on film.

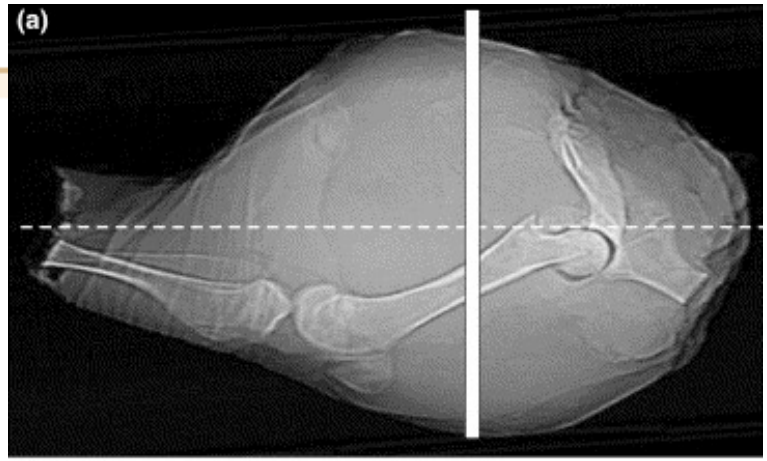


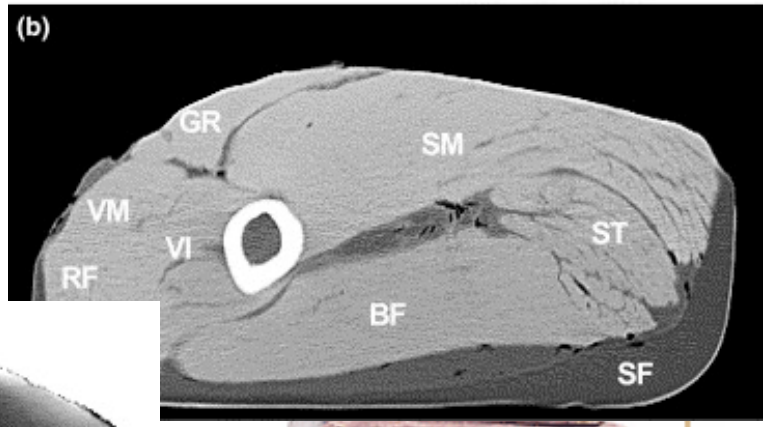


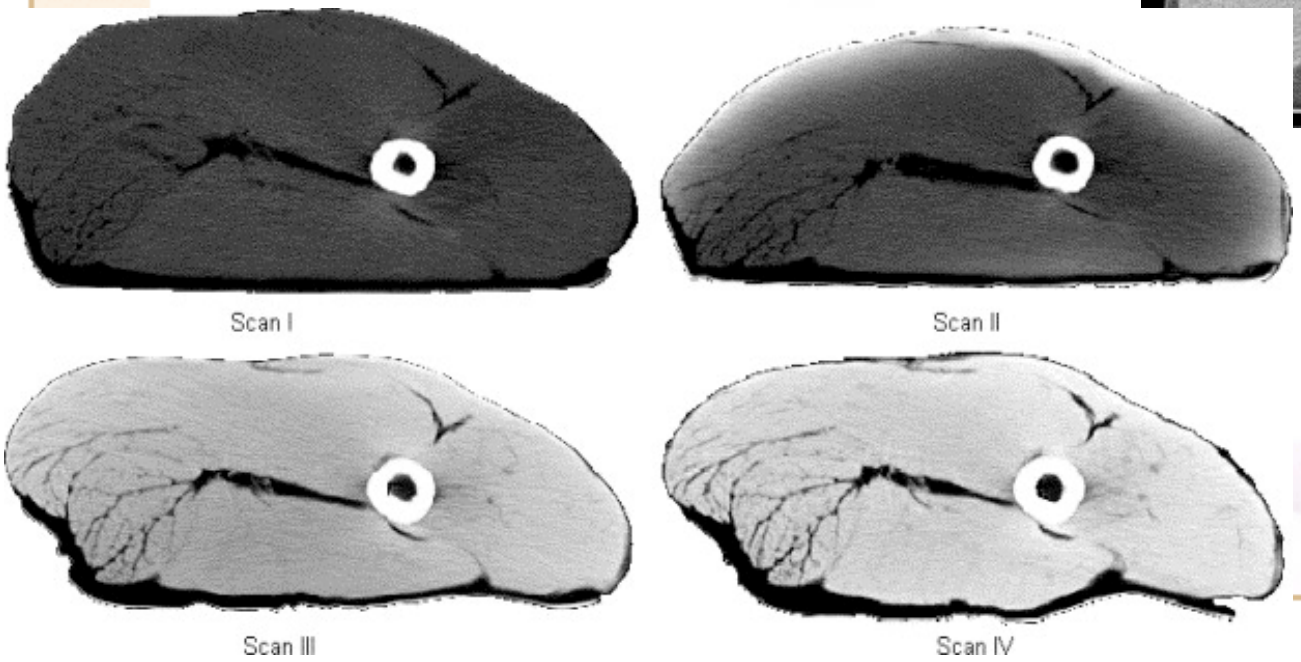
CT Scan (Computed Tomography, or CAT scan)

- CT scans provide many cross-sectional images of the body by using special X rays and computer enhancement to create an image that is much more sensitive than a simple X ray. After x-raying the body from many angles, the X rays are then analyzed by a computer to provide a picture of the body that can be viewed on a monitor or printed out as a photograph. The images show a composite slice of the body (usually the head, chest, or abdomen).

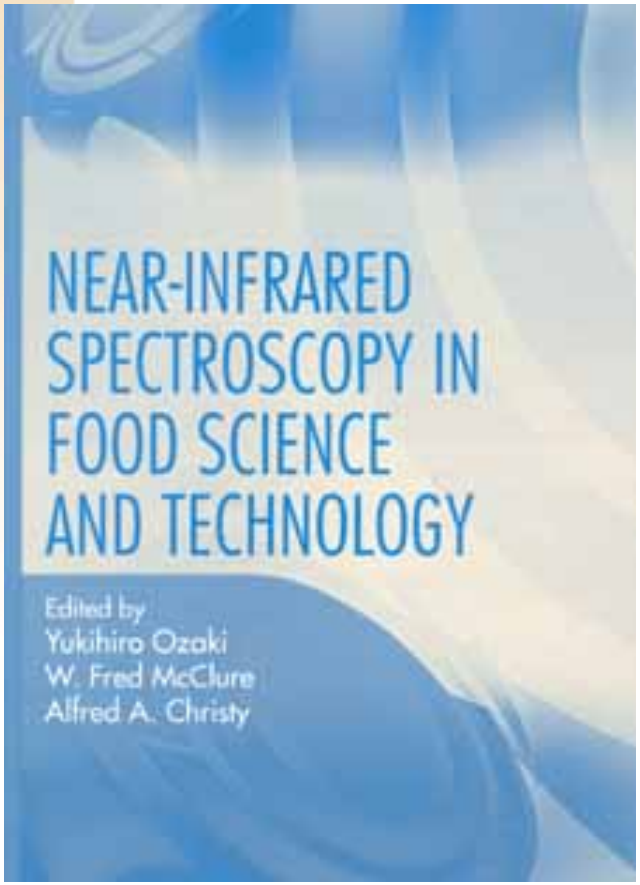
- Muscle anatomy
- Salt diffision

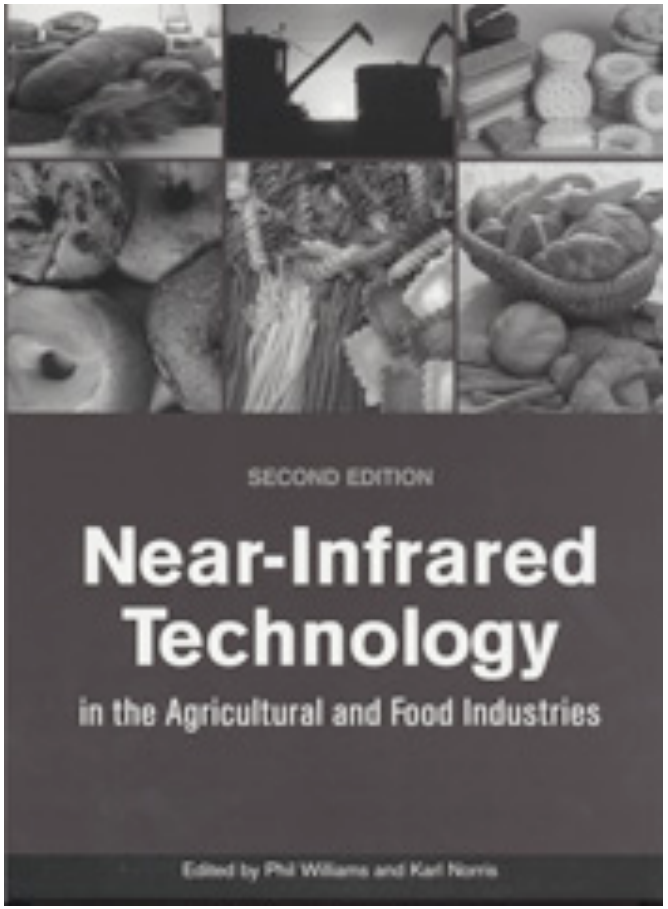






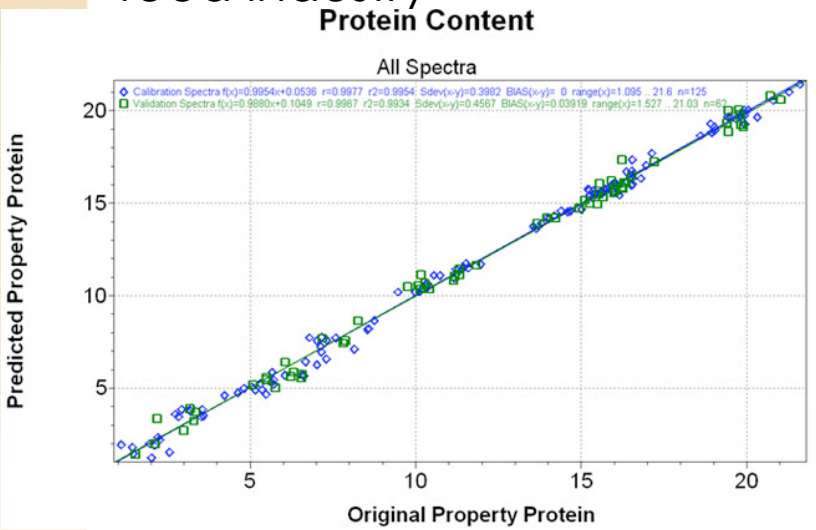
NIR techniques



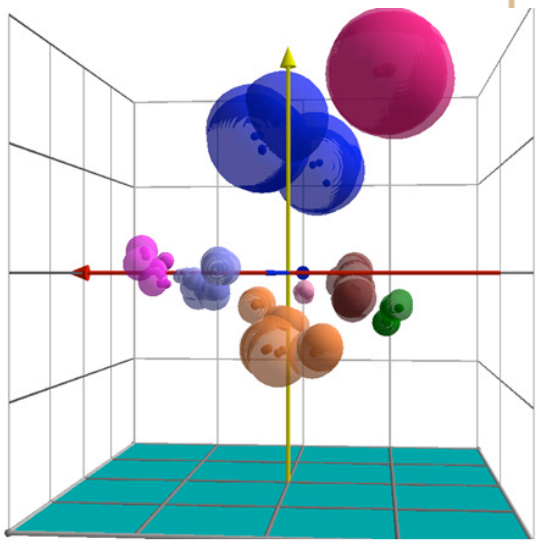


http://www.thermo.com/com/cda/landingpage/0,,1520,00.html?WT.srch=1&gclid=CNKpt8ylq50CFVFf4wodp3gekg

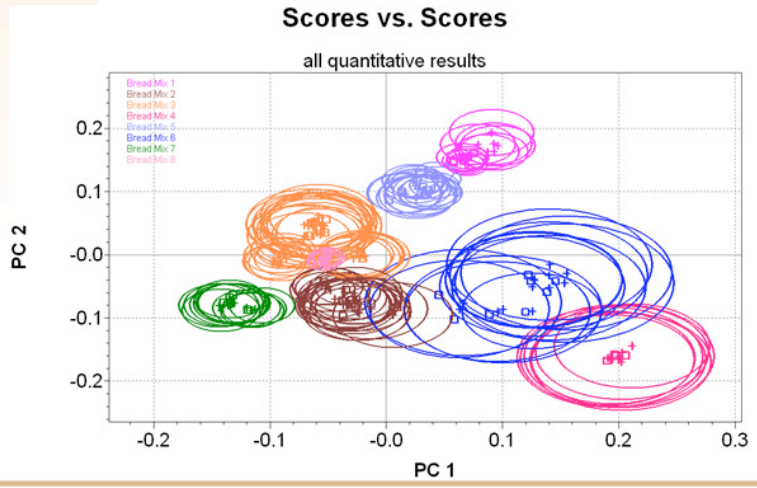
The use of Cluster ID Method for distinct identification of quality aspects in the food industry



Partial Least Squares (PLS) calibration curve for Protein

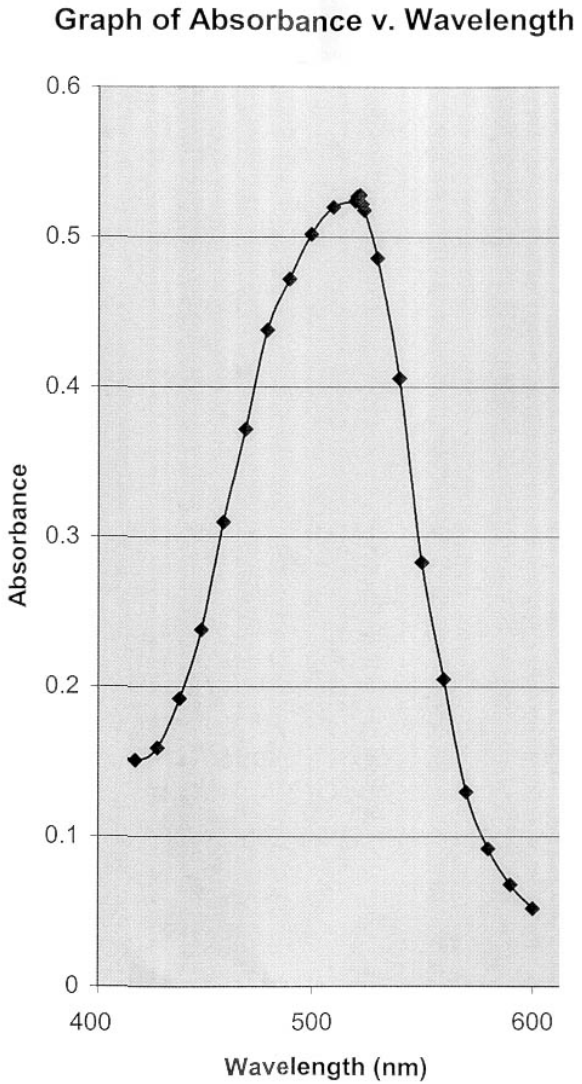


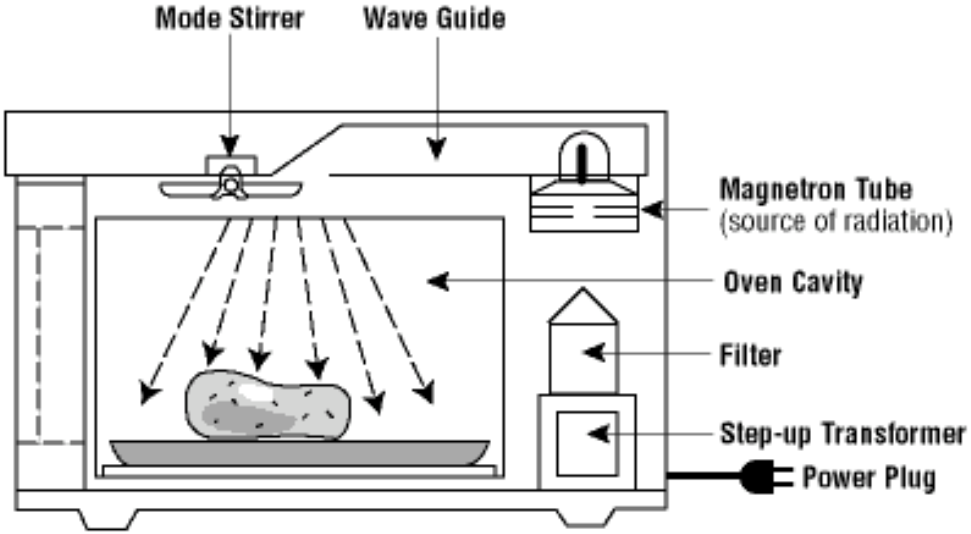
3D-Score plot that shows the classification of different bread mixtures into individual clusters

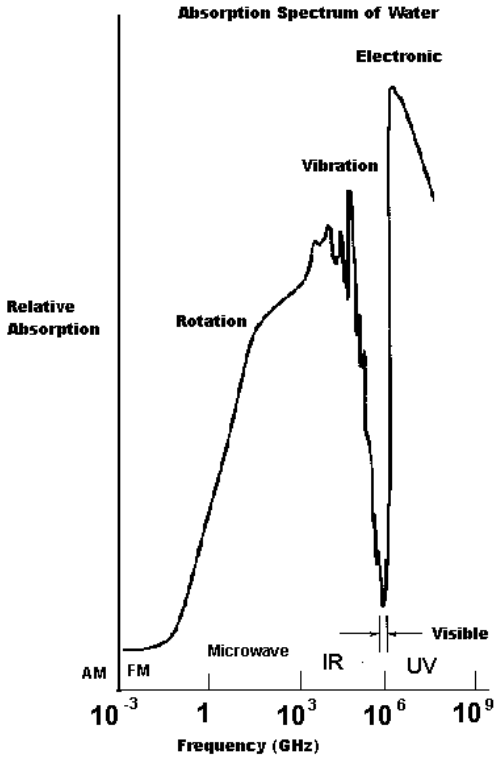


Score plot of 8 different bread mixtures based on the significant differences of analytical results

MICROWAVES

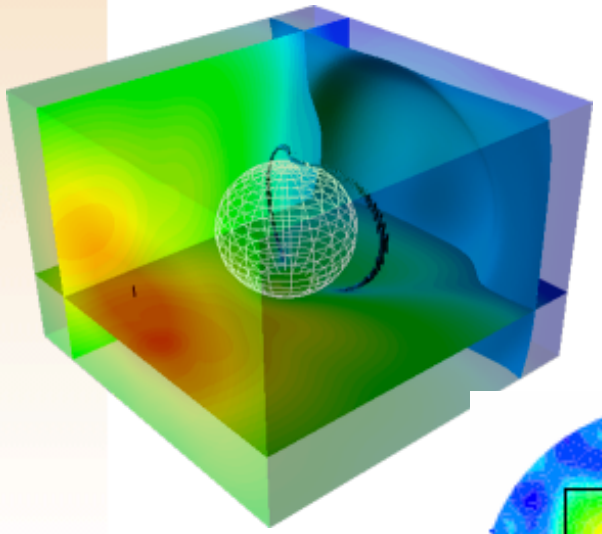

Graph of Absorbance v. Wavelength
Absorbance
0.6
0.5
0.4
0.3
0.2
0.1
0
400
500
600
Wavelength (nm)

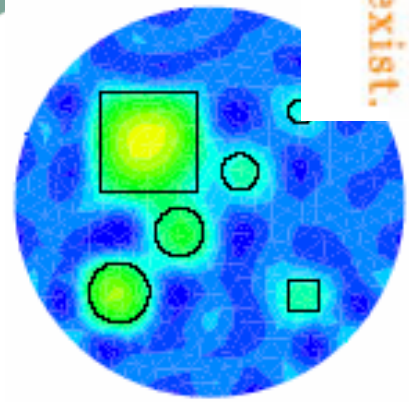

Mode Stirrer
Wave Guide
Magnetron Tube
(source of radiation)
Oven Cavity
Filter
Step-up Transformer
Power Plug


Absorption Spectrum of Water
Electronic
Vibration
Rotation
Relative Absorption
Visible
Microwave
IR
UV
AM
FM
10 -3
1
10 3
10 6
10 9
Frequency (GHz)

MICROWAVE TOMOGRAPHY

- BASIS: Detection of different dielectric properties

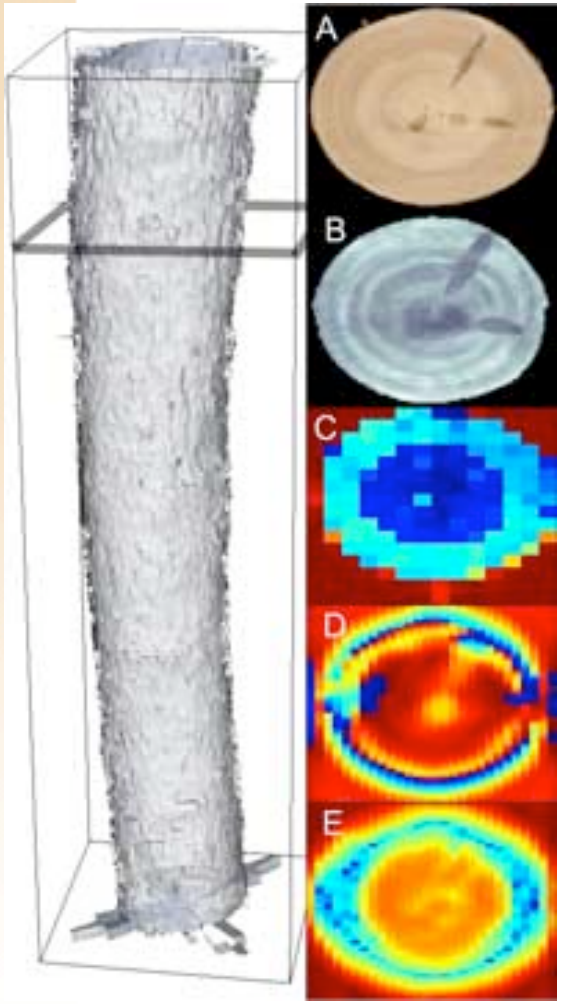




Microwave Functional Spectrum Tomography prototype—including microwave antennas and motion-controlling linear actuators—for detecting breast cancer.

http://nmr.mgh.harvard.edu/~fangq/

http://engineering.dartmouth.edu/faculty/regular/paulmeaney.html



- On the left is the 3D-model of a log and on the right a cross section from the same log. A is a photograph of the cross section, B represents a calculated density estimate, C shows the moisture distribution measured with near-infrared spectroscopy, D the microwave absorption and E the microwave reflectance map of the cross section.

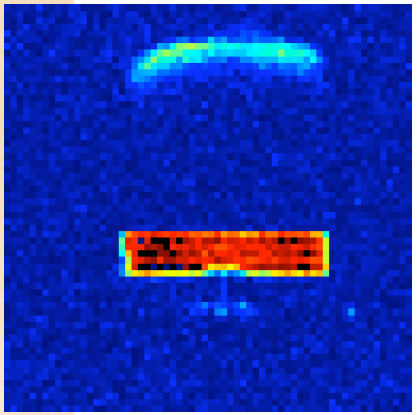
http://www.infotech.oulu.fi/Annual/2005/opme.html

MRI (Magnetic Resonance Imaging)

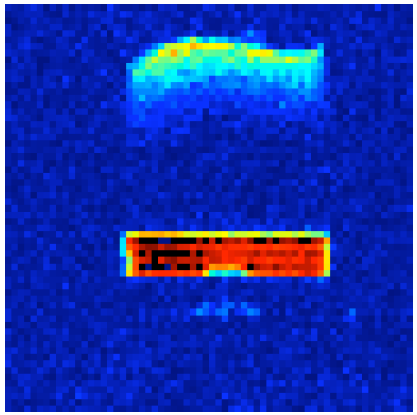
- Another way to take pictures of the inside of the body involves the use of magnetism and radio waves to produce much more detailed images than an X ray because of its ability to separate different types of soft tissues. As radio waves are sent to a specific part of the body, the atoms emit their own radio waves that are translated into images by a computer. MRI can be used to look at any area of the body and is especially useful in diagnosing disease of the soft tissues of the head, spinal cord, kidneys, urinary tract, pancreas, and liver. MRIs are also the procedure of choice to detect sports injuries involving tendon and ligament damage.

Saltprofiler: Baccalaoprøver

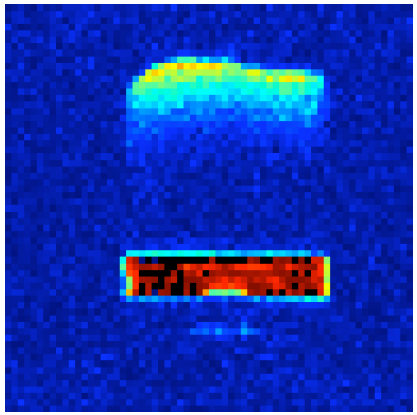
SINTEF (Norway)



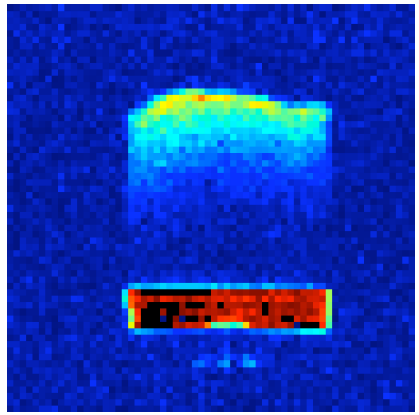
Dag 1



Dag 2



Dag 3



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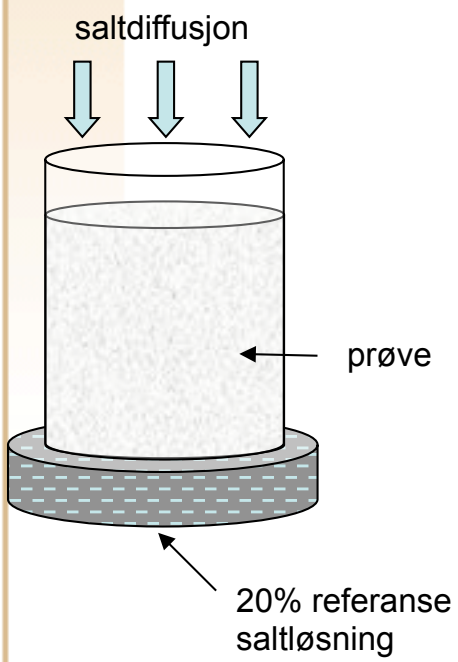

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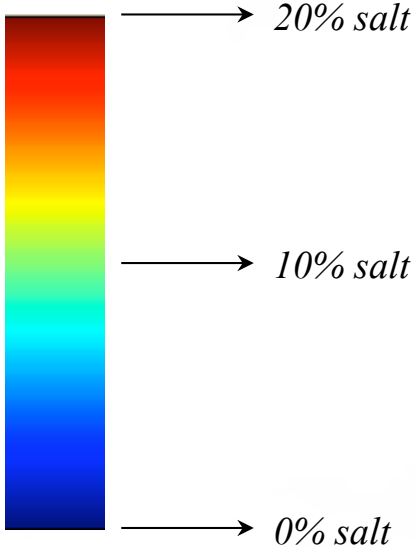
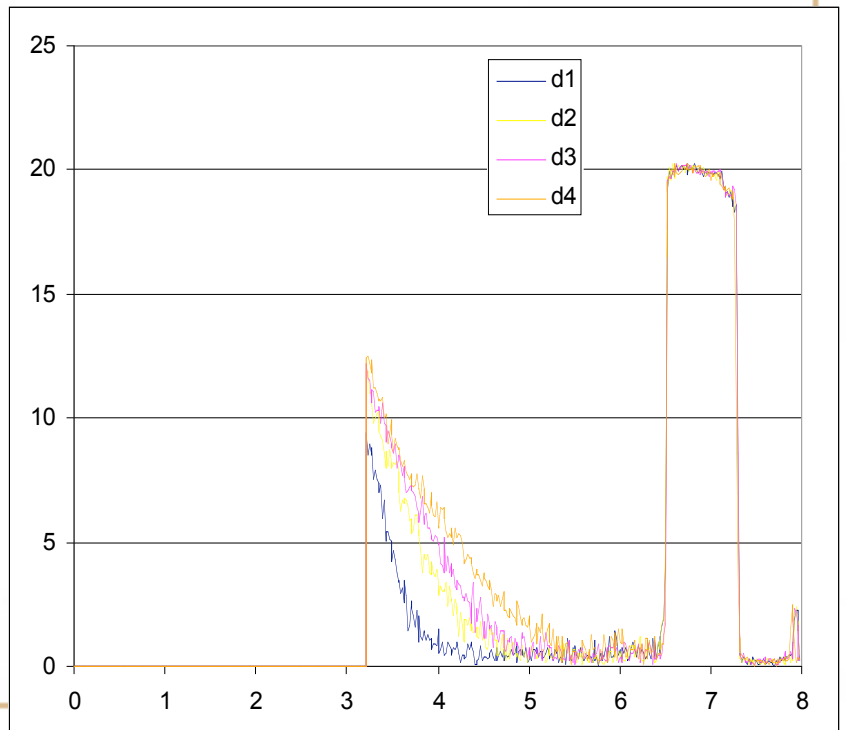
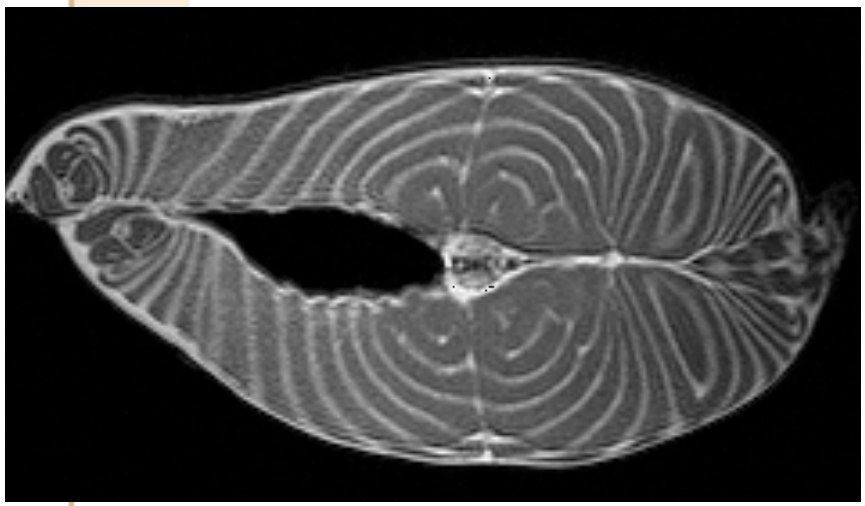


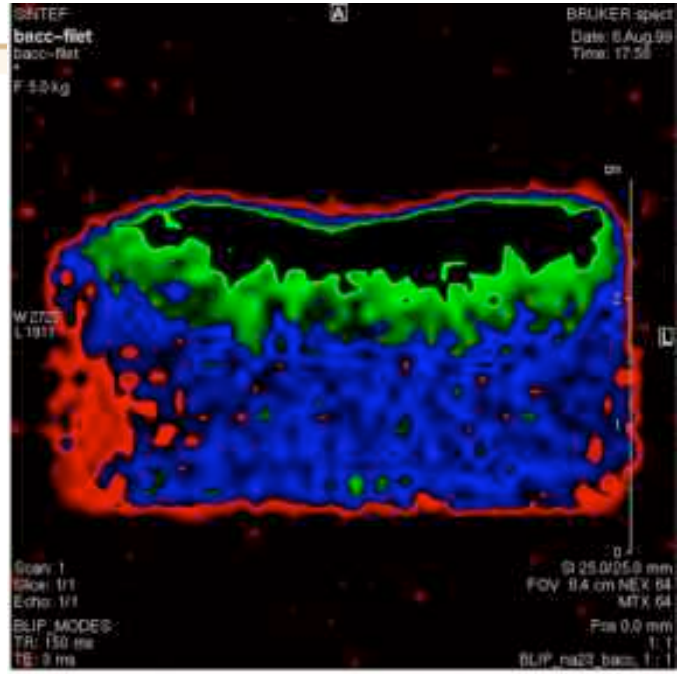


Saltdistribusjon i torsk

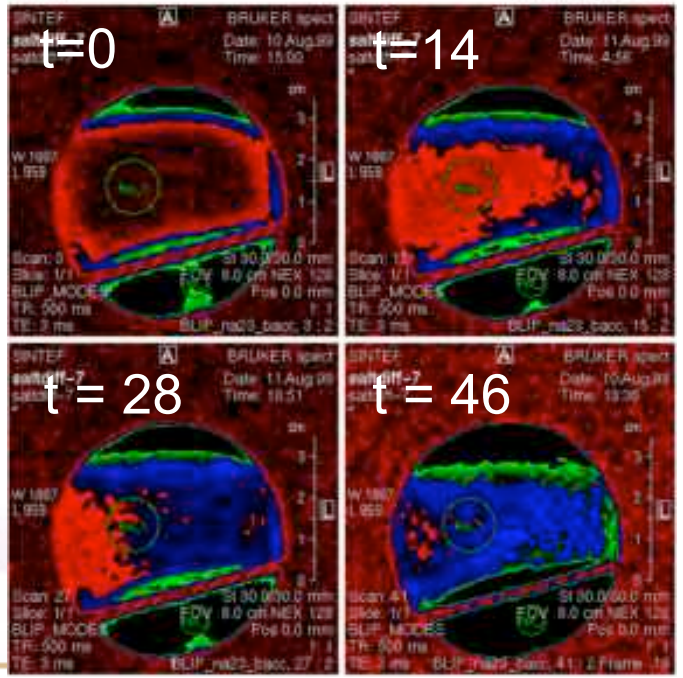
Lakesalting, 16,5% NaCl, 43 h, 3C - 5C



Statisk studium



Dynamisk studium



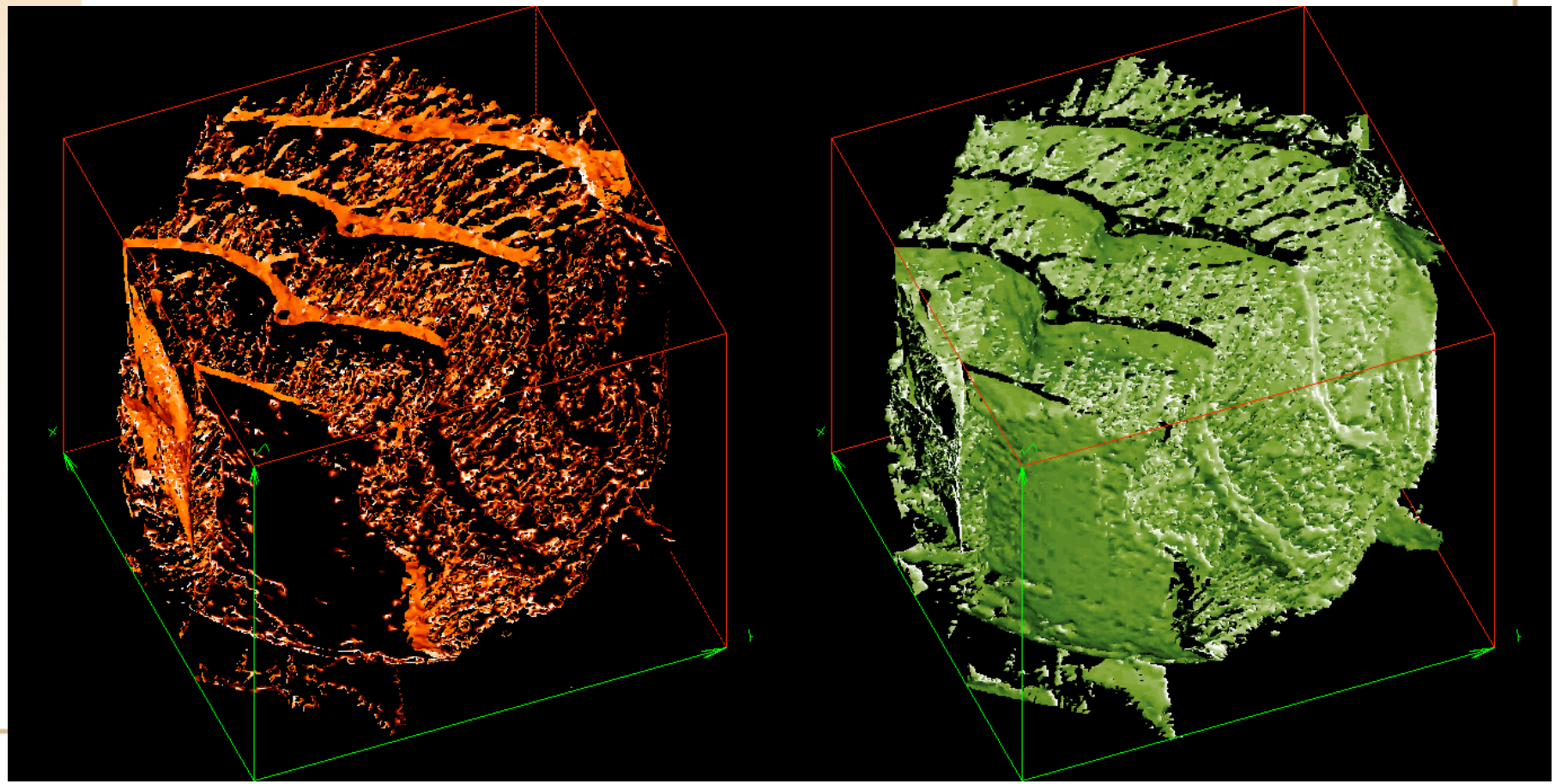
SINTEF (Norway)

SINTEF (Norway)

3D imaging: separasjon av fett/bindevev fra vann

Fett/bindevev

Vann

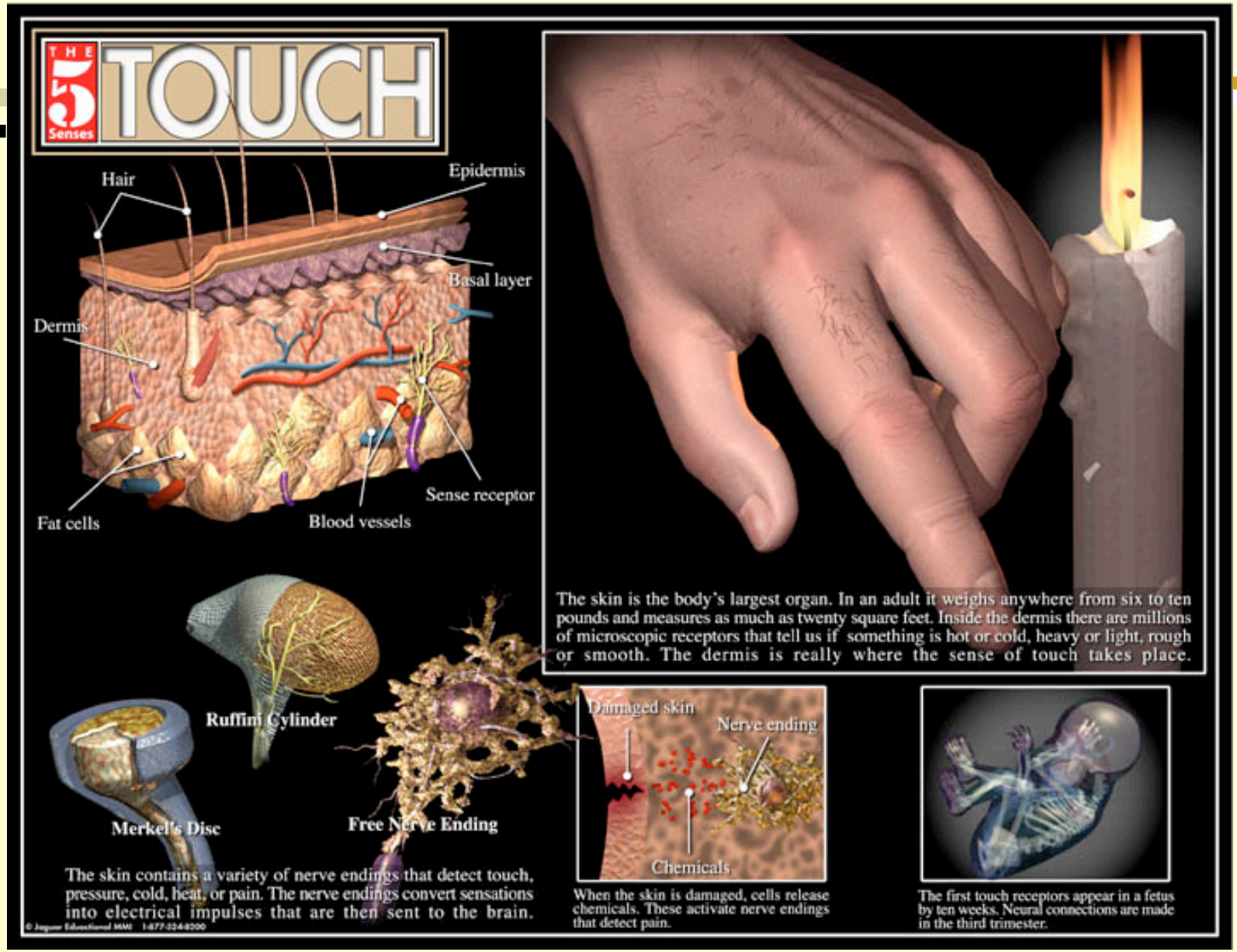


ULTRASOUNDS

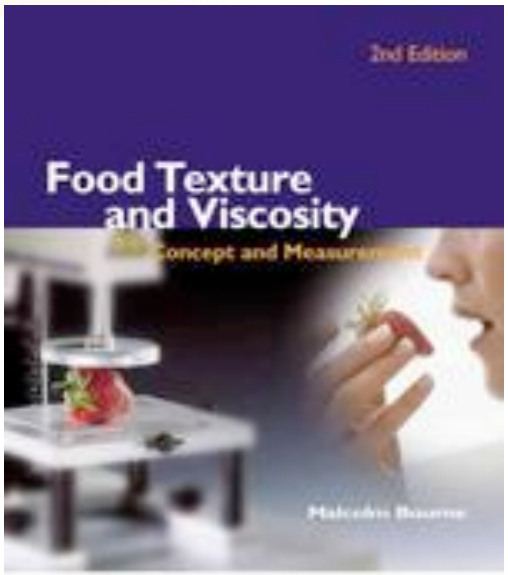
ACOUSTIC WAVE

- Frequency higher than the limit of the human ear (aprox 20.000 Hz)
- For medical application between 2 and 3 MHZ

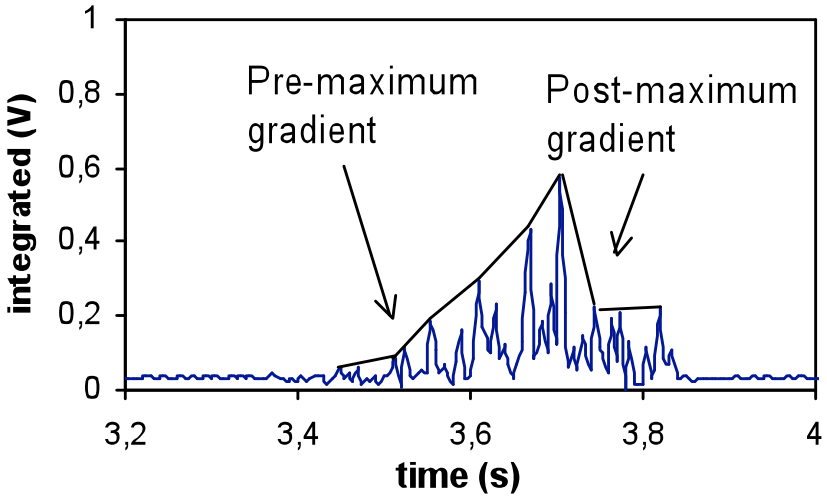
ULTRASOUNDS

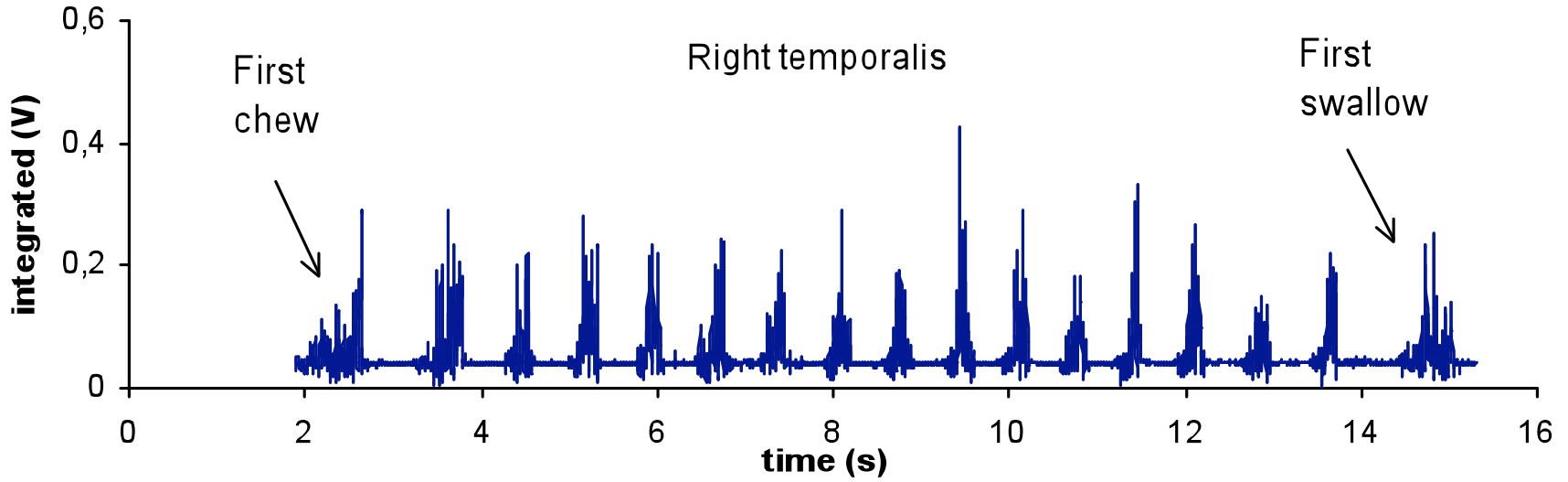

THE 5 Senses
TOUCH
Hair
Epidermis
Basal layer
Dermis
Fat cells
Blood vessels
Sense receptor
The skin is the body's largest organ. In an adult it weighs anywhere from six to ten pounds and measures as much as twenty square feet. Inside the dermis there are millions of microscopic receptors that tell us if something is hot or cold, heavy or light, rough or smooth. The dermis is really where the sense of touch takes place.
Ruffini Cylinder
Merkel's Disc
Free Nerve Ending
The skin contains a variety of nerve endings that detect touch, pressure, cold, heat, or pain. The nerve endings convert sensations into electrical impulses that are then sent to the brain.
Damaged skin
Nerve ending
Chemicals
When the skin is damaged, cells release chemicals. These activate nerve endings that detect pain.
The first touch receptors appear in a fetus by ten weeks. Neural connections are made in the third trimester.

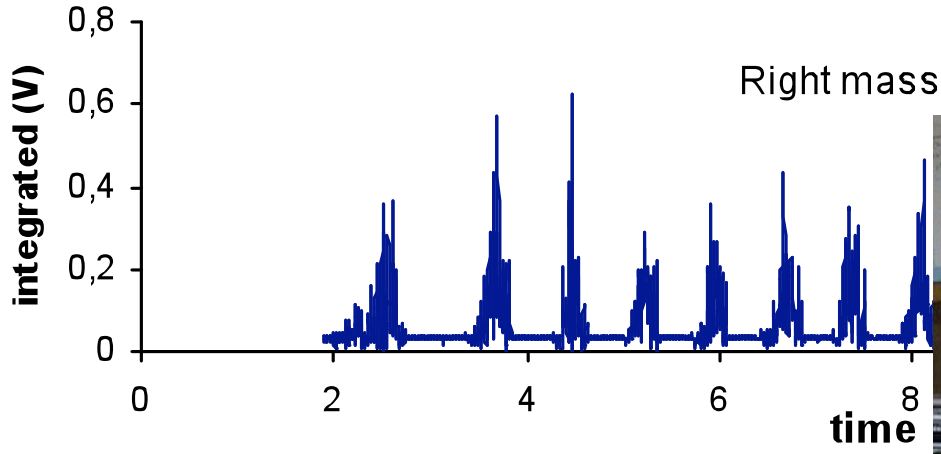
- Hardness
- Firmness
- Adhesiveness
- Cohesiveness
- Gumminess
- Springiness
- Viscosity
- ……



Use of electromyography




First
chew
Right temporalis
First
swallow
integrated (V)
0,6
0,4
0,2
0
0
2
4
6
8
10
12
14
16
time (s)


Right masseter
integrated (V)
0,8
0,6
0,4
0,2
0
0
2
4
6
8
time

Evaluation of food texture by using ultrasounds

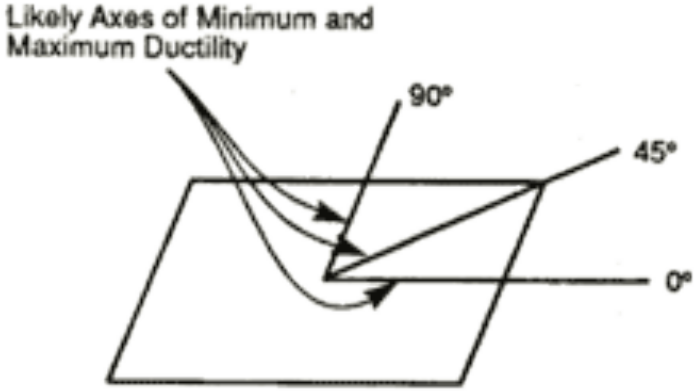


Figure 1
Directionality in Properties of a Rolled Sheet

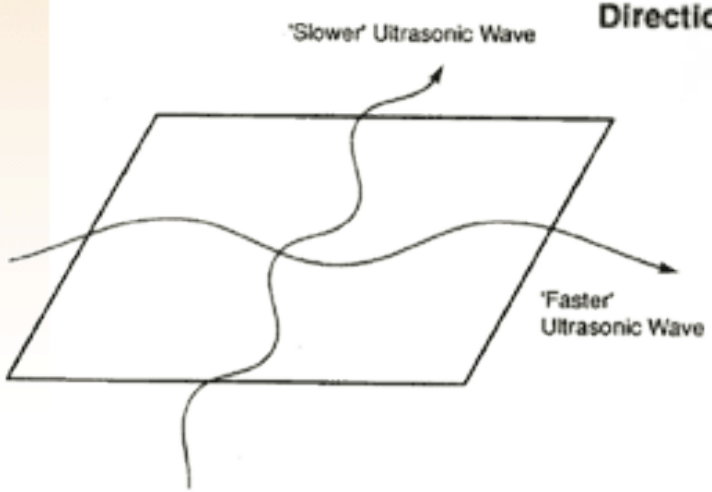
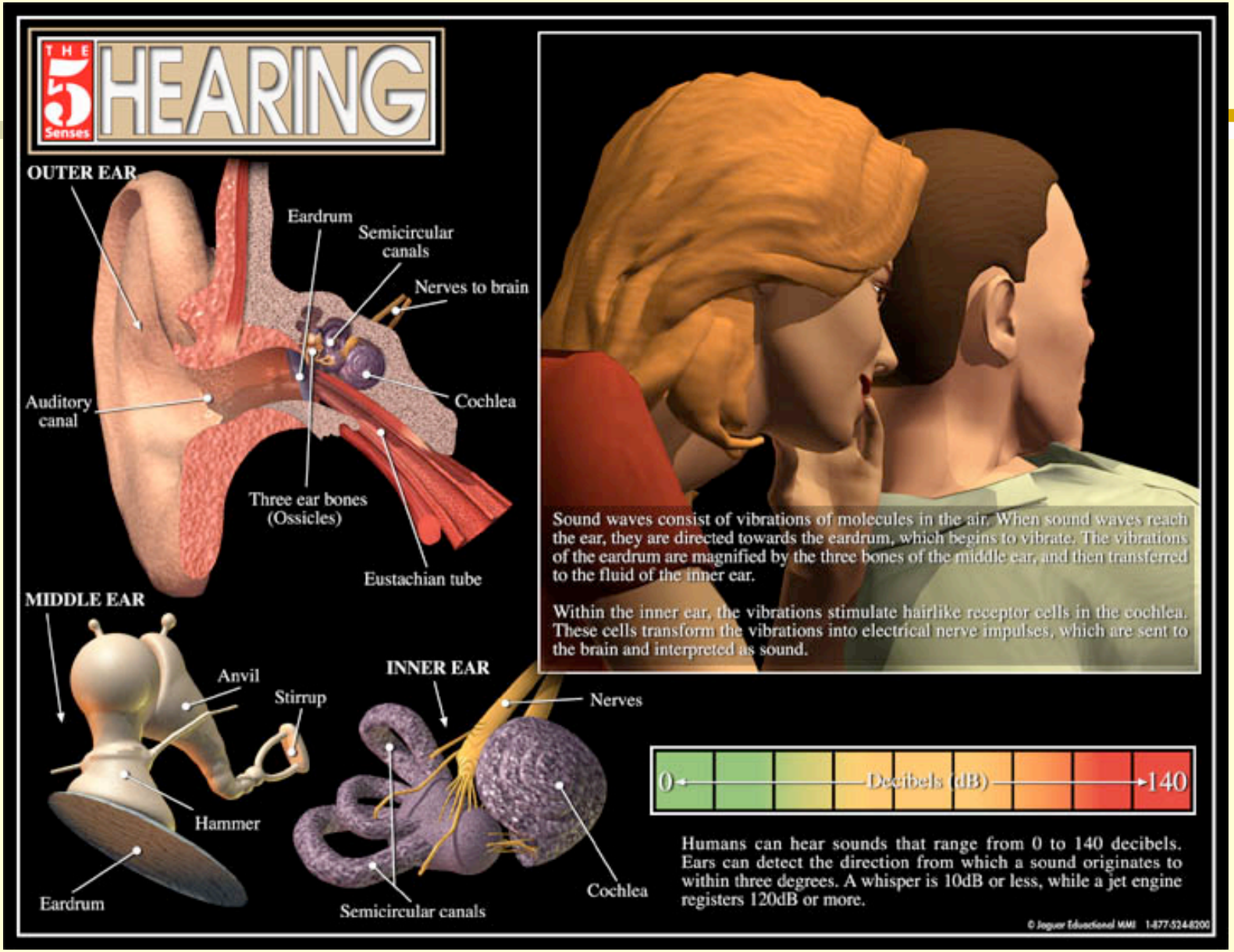


Figure 8
Effects of Texture on Wave Speed

http://www.nfri.affrc.go.jp/english/organization/kinou/syokuhinbussei.html


THE 5 Senses
HEARING
OUTER EAR
Eardrum
Semicircular canals
Nerves to brain
Auditory canal
Cochlea
Three ear bones (Ossicles)
Eustachian tube
MIDDLE EAR
Anvil
Stirrup
Hammer
Eardrum
INNER EAR
Nerves
Semicircular canals
Cochlea
Sound waves consist of vibrations of molecules in the air. When sound waves reach the ear, they are directed towards the eardrum, which begins to vibrate. The vibrations of the eardrum are magnified by the three bones of the middle ear, and then transferred to the fluid of the inner ear.
Within the inner ear, the vibrations stimulate hairlike receptor cells in the cochlea. These cells transform the vibrations into electrical nerve impulses, which are sent to the brain and interpreted as sound.
0
Decibels (dB)
140
Humans can hear sounds that range from 0 to 140 decibels. Ears can detect the direction from which a sound originates to within three degrees. A whisper is 10dB or less, while a jet engine registers 120dB or more.
© Jaguar Educational Mfd 1-877-524-8200

Sound Advice

- An indicator of freshness and high quality, crispness is a pivotal factor in determining the appeal of crunchy and crispy products such as biscuits, cereals, crisps and hard varieties of fruit and vegetables. One of the most prominent characteristics of crunchy and crispy foods is the acoustic energy emitted upon their disintegration during chewing or mechanical testing.

http://www.texturetechnologies.com/Press_Releases.html

- In response to demand from universities and commercial research departments, Stable Micro Systems, one of the world's leading providers of texture analysis equipment, has designed and launched its new Acoustic Envelope Detector. Used with the TA.XTPlus texture analyser, the new instrument offers manufacturers a quick and easy method of collecting and analysing the noise released by crispy products as they are deformed. Together with an instrument designed to measure force, distance and time, this innovation adds a new dimension to texture analysis and quality control.

Acoustic microscope for colloid characterization

IMPACT ACOUSTIC DETECTION

- Use for Beans separation

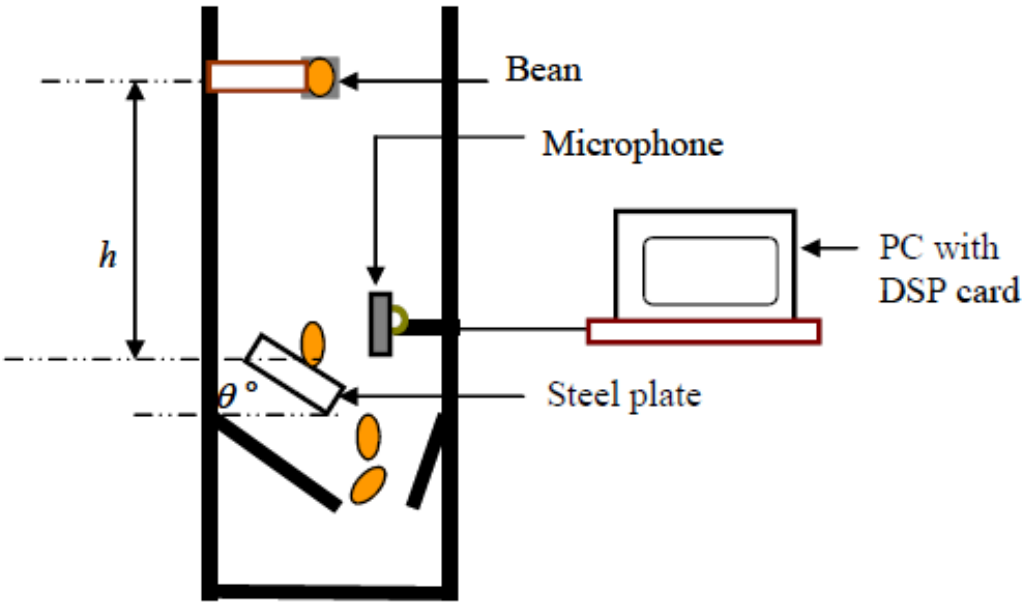
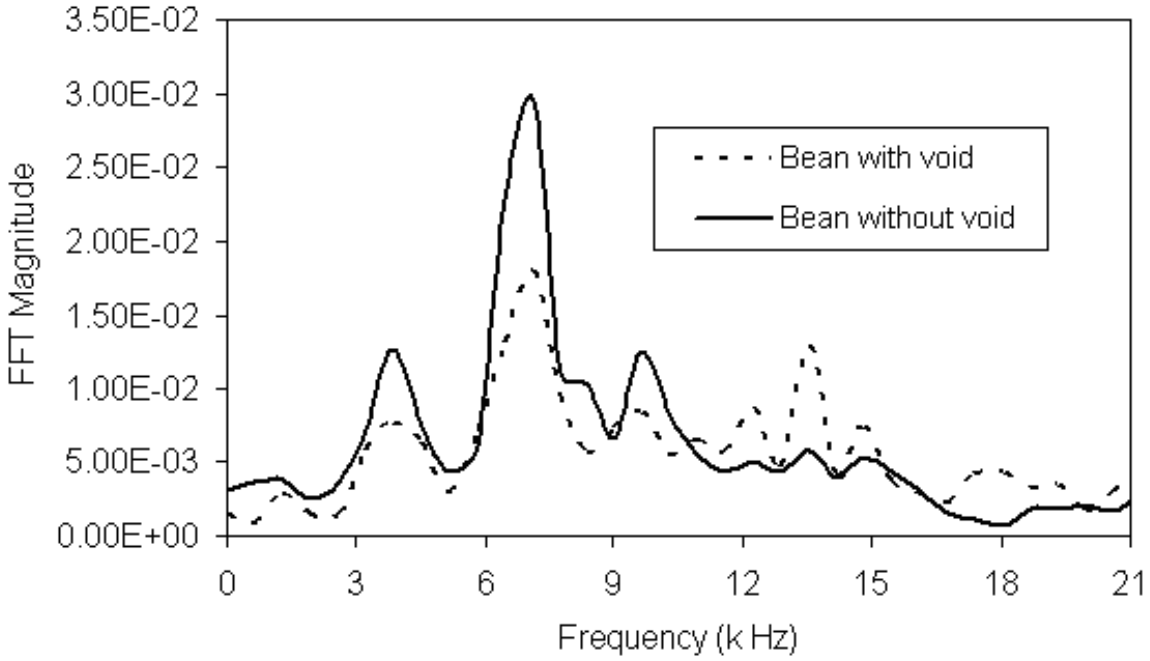


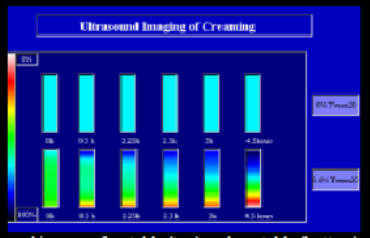
Fig. 2. Schematic of impact acoustic detection (IAD) system: h and θ ° are bean dropping height and steel plate angle respectively



Typical frequency spectra of the impact sound from raw pinto beans with and without voids.

http://www.food.leeds.ac.uk/mp.htm

Acoustic microscope for colloid characterisation

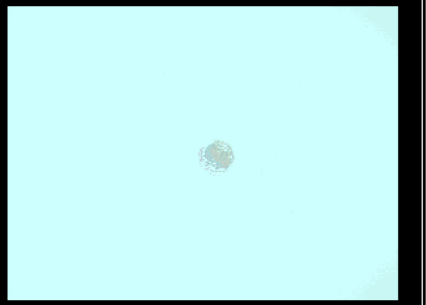


Ultrasound images of a stable (top) and unstable (bottom) colloid

Malcolm Povey

Professor of Food Physics
Procter Department of Food Science
University of Leeds
LEEDS LS2 9JT UK
m.j.w.povey@food.leeds.ac.uk
tel: 0113 343 2963 fax: 0113 343 2982

Stable Microsystems texture analyser and acoustic envelope detector



A pulse of sound passing an oil drop suspended in water.

Potato chips make ultrasound when we eat them!

Sounds Hard, Sounds Soft, Sounds Tasty, Sounds Crisp

Ultrasound - what it is and what it can do

USE OF ULTRASOUNDS

DETECTION OF CRACKS IN CHEESE

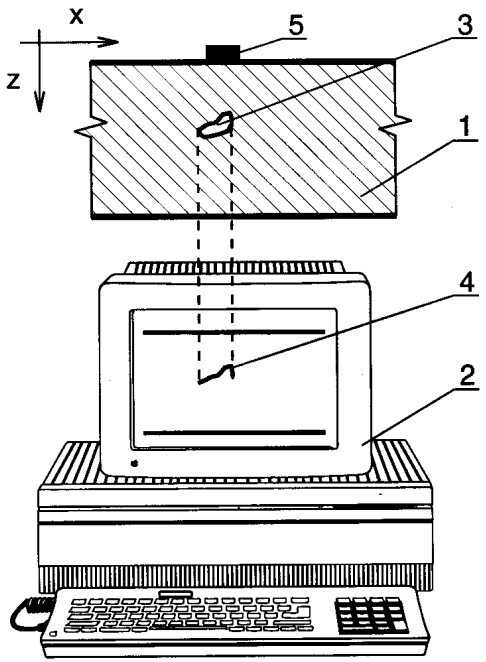


Fig. 5.8 *Projection B*
1 - medium, 2 - CRT screen, 3 - defect, 4 - defect projection, 5 - ultrasonic probe

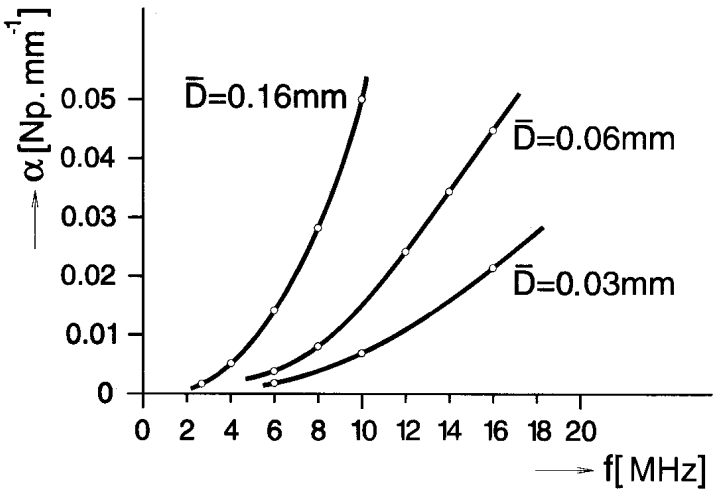


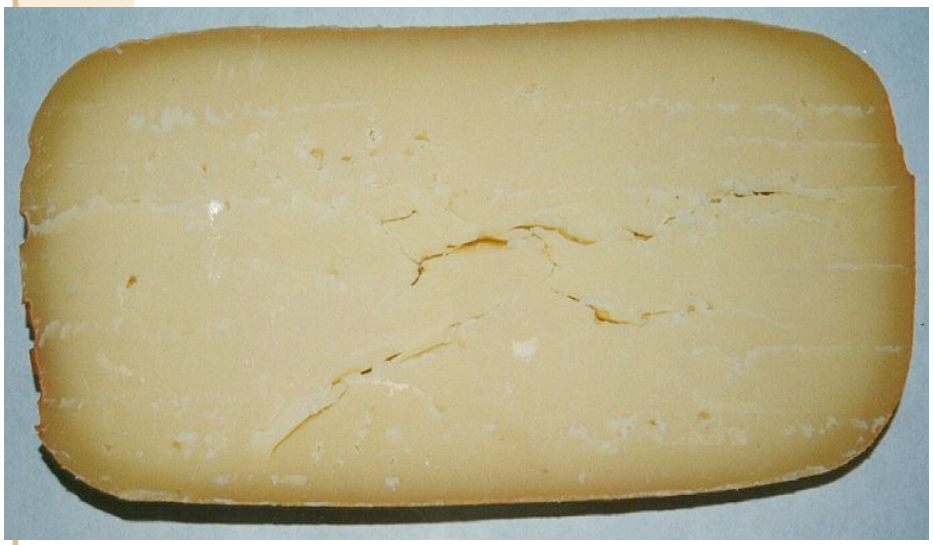
Fig. 2.5 *Dependence of the attenuation coefficient, α, on frequency, f, for carbon steel*

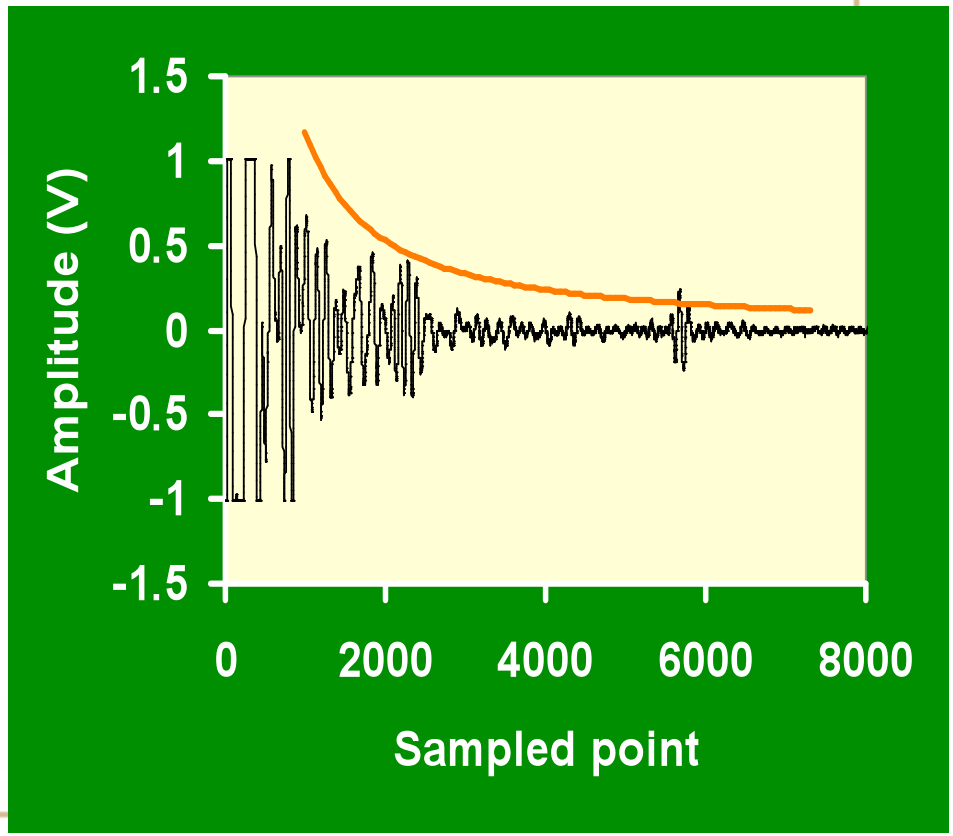

PR5000-HP

APPLICATIONS TO CHEESE MANUFACTURING

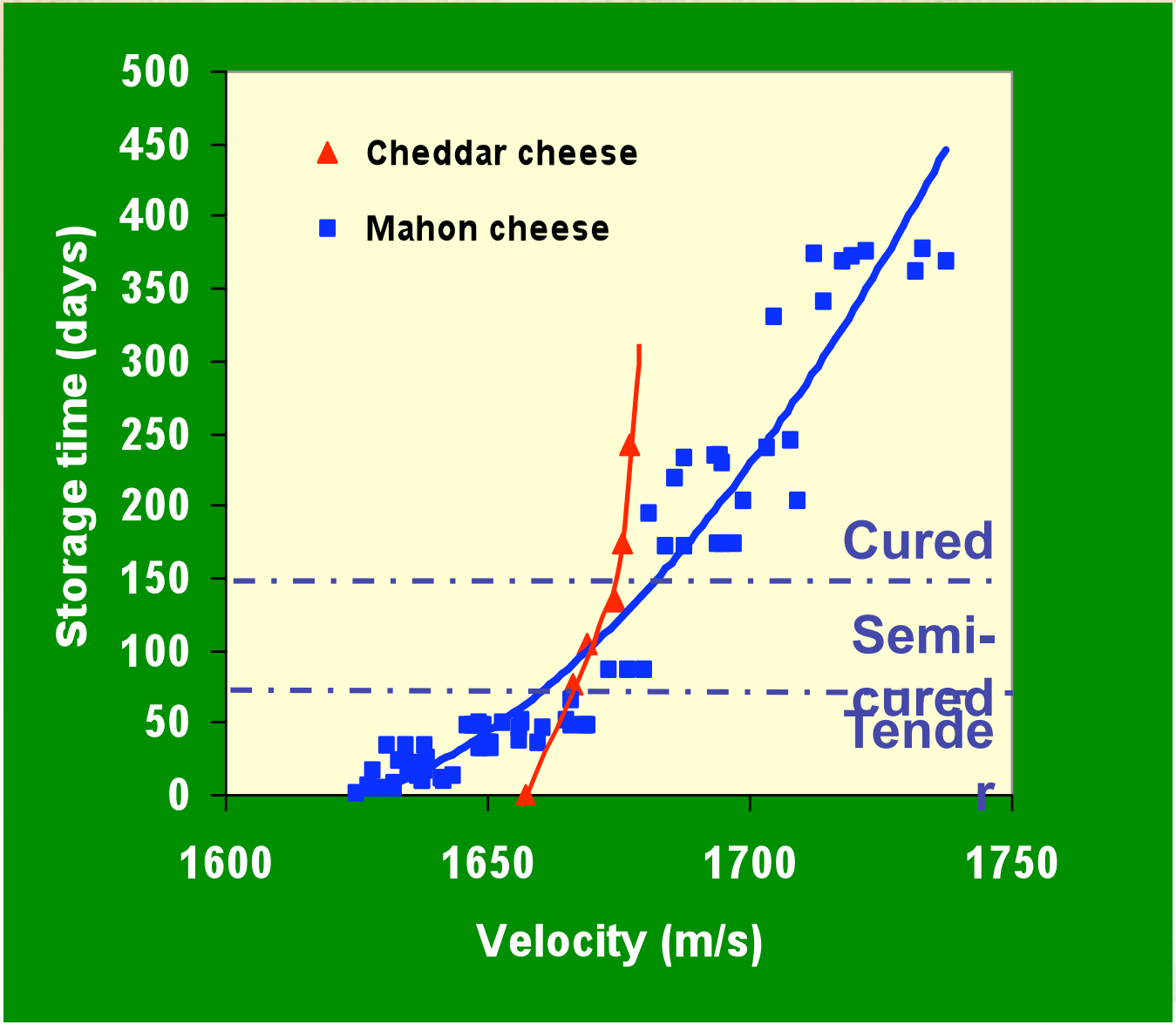
Quality control: Cracks

- A problem that affects cheese maturation is the development of abnormal fermentations ⇒ cracks



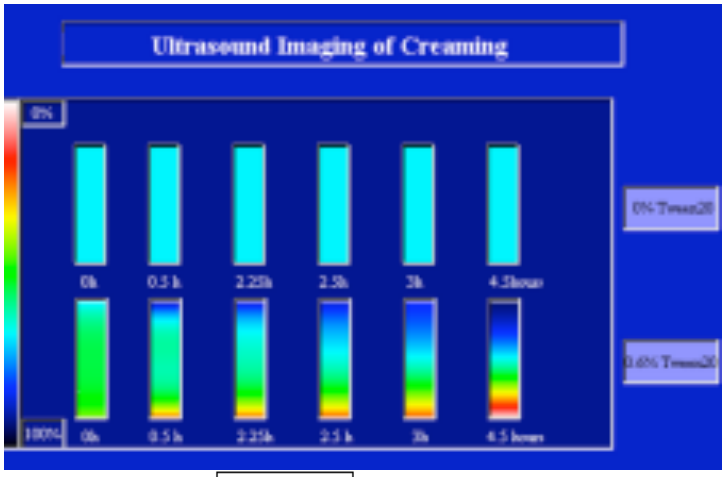


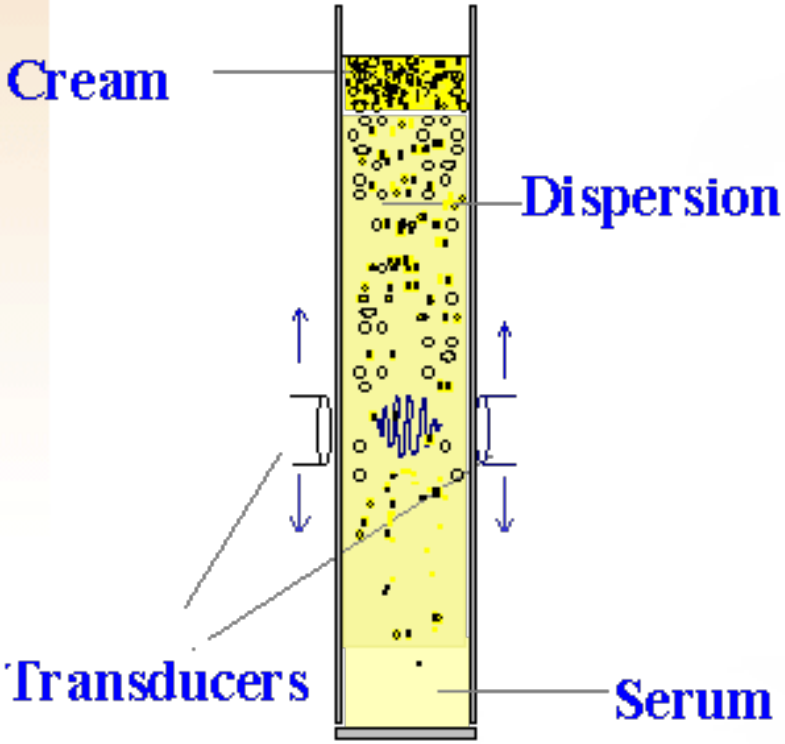
ULTRASONIC MATURITY MONITORING

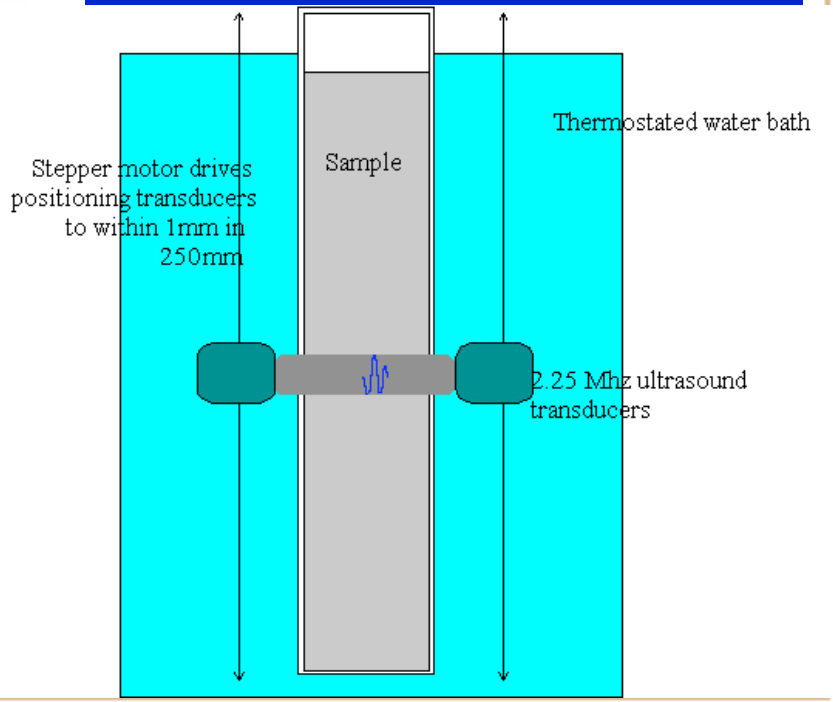


STUDY EMULSIONS STABILITY

- Timer accuracy is 1 ns
- Velocity accuracy in water at 20 °C is 1 m s^{-1}
- Velocity precision in water at 20 °C is 0.1 m s^{-1}
- Accuracy of volume fraction determination in 20% hexadecane oil-in-water emulsion is 0.1 %

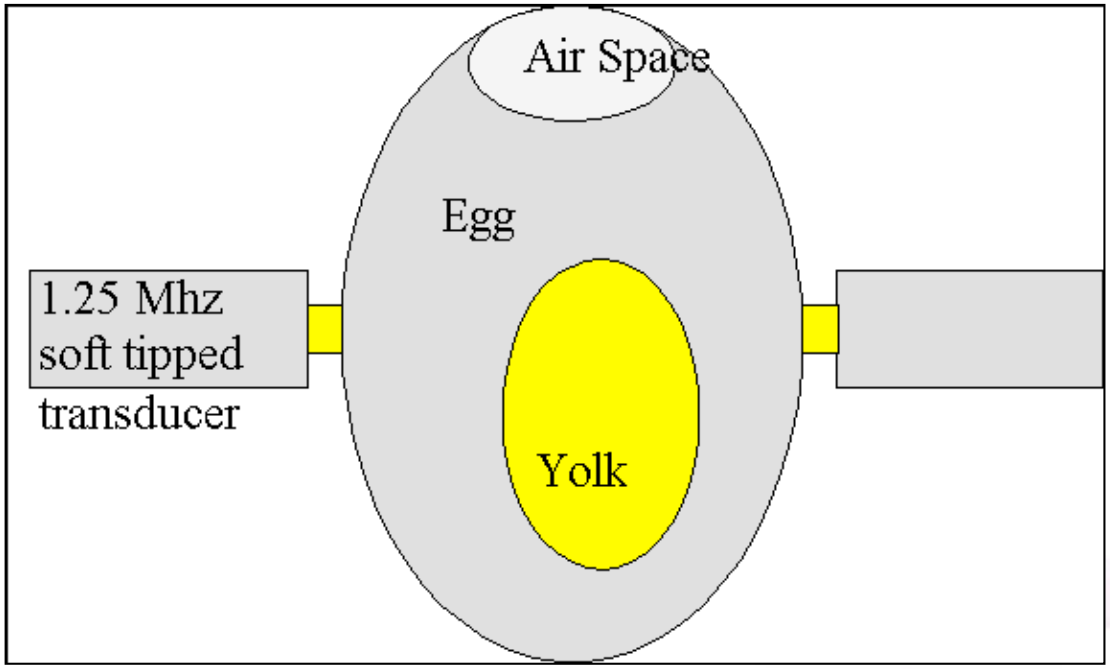


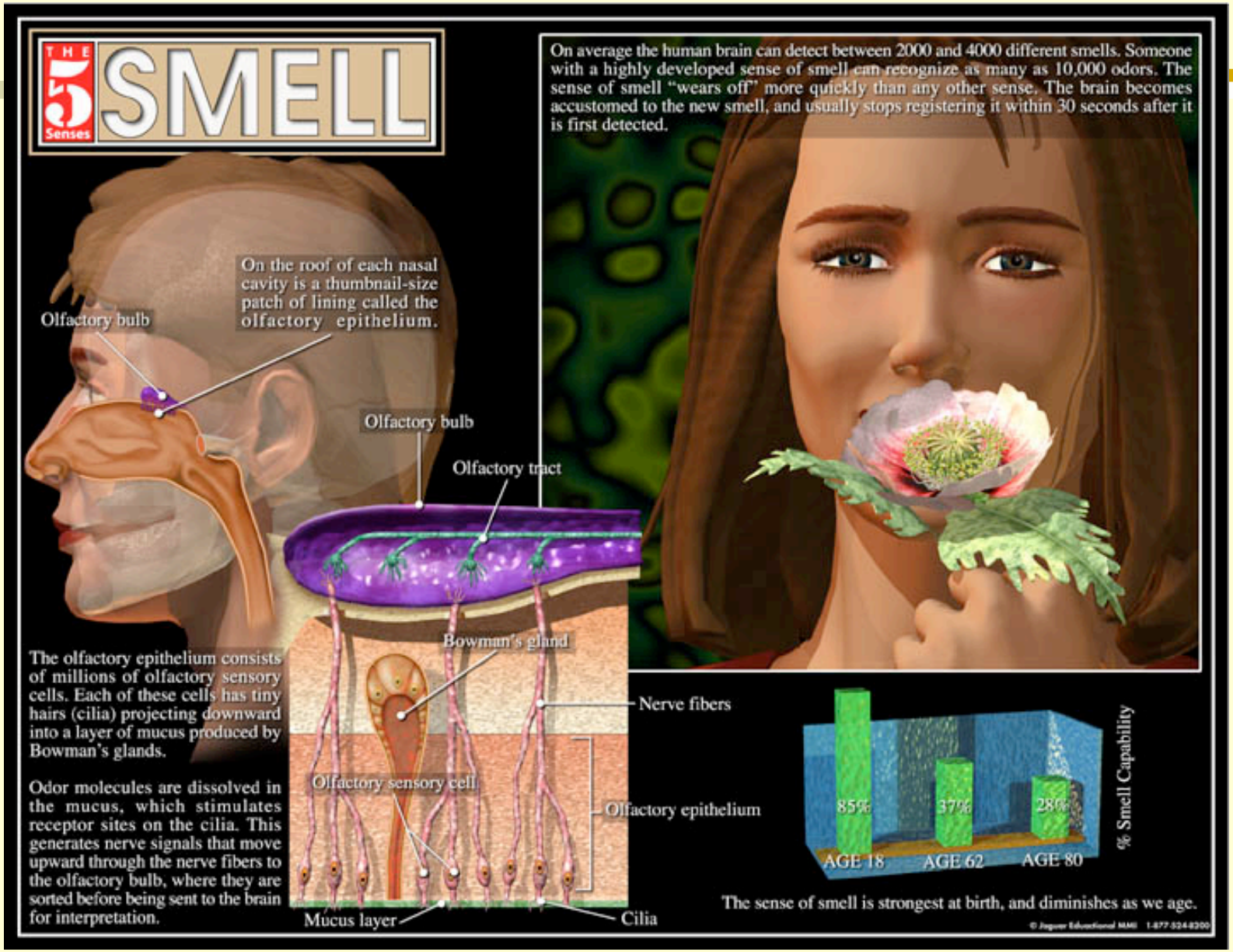


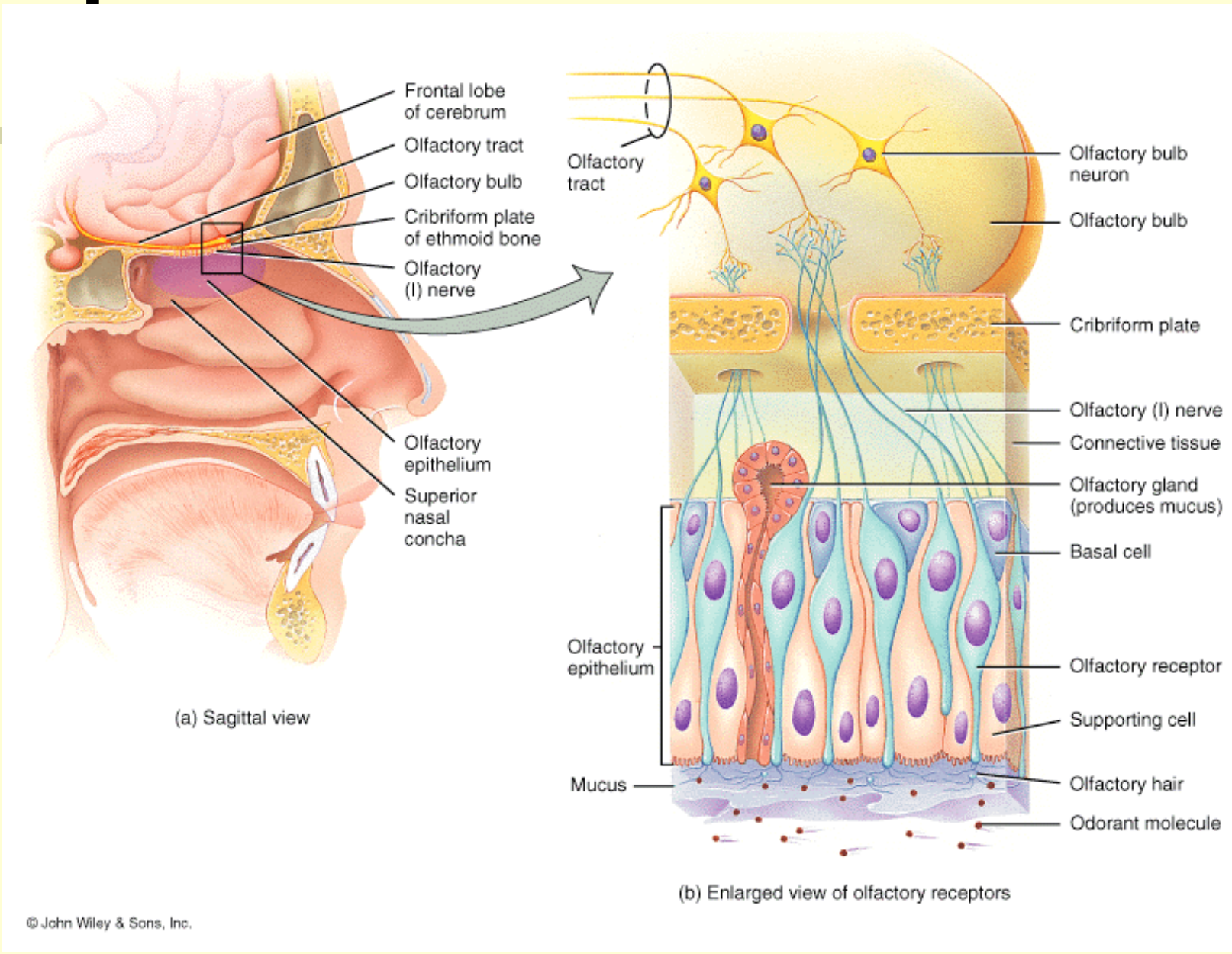


MEASUREMENT OF EGG FRESHNESS

- **LAS PROTEINAS DE LA CLARA DEL HUEVO SE VUELVEN MÁS TRANSPARENTES A LOS ULTRASONIDOS CONFORME ENVEJECEN**
- **HACIENDO VARIAR LA FRECUENCIA HASTA QUE EL CONJUNTO PIEZA A EXAMINAR Y CRISTAL PRODUCTOR DE LA SEÑAL, VIBREN A LA FRECUENCIA DE RESONANCIA QUE ES FUNCIÓN DEL ESPESOR DE LA PIEZA.**

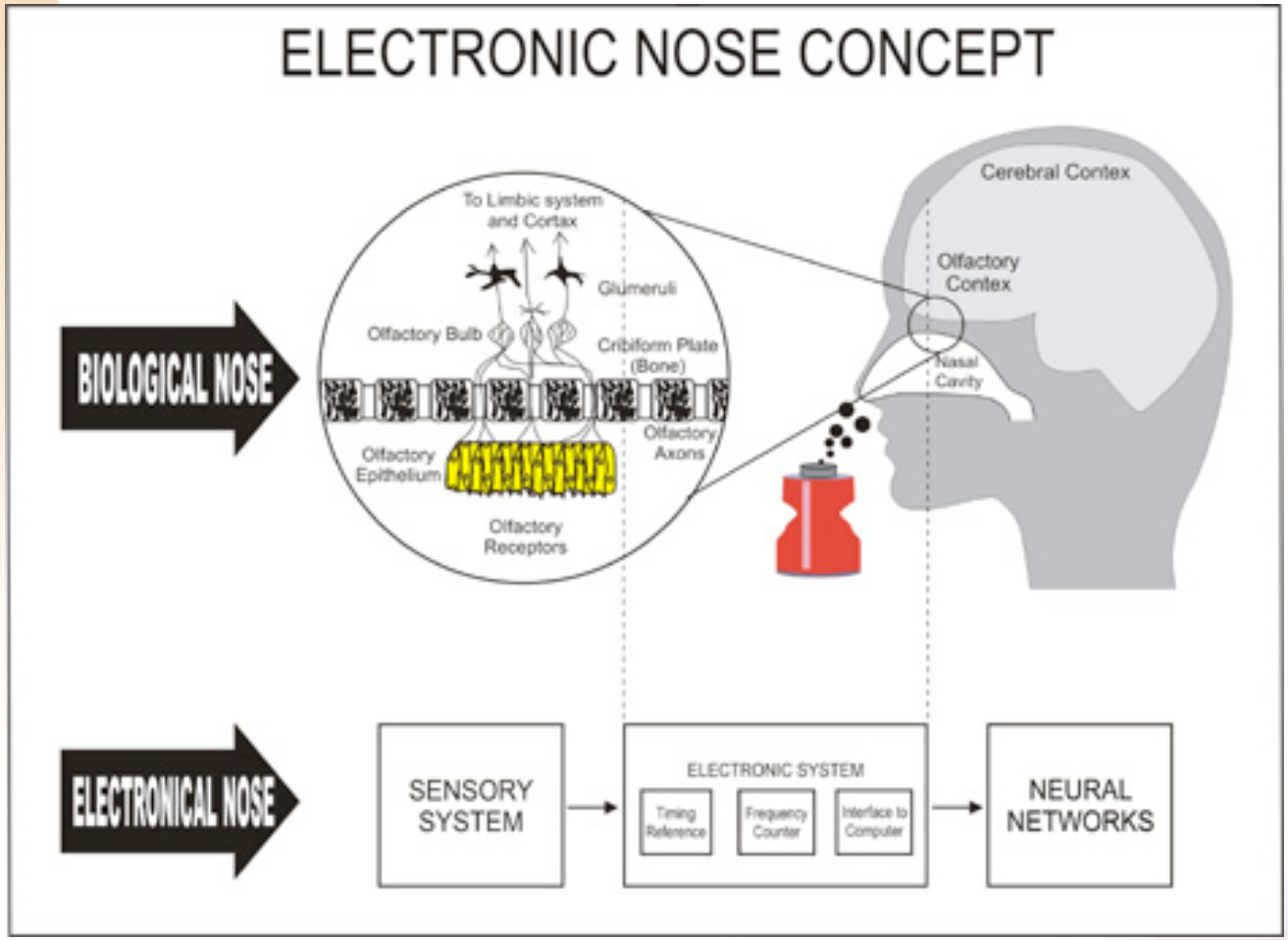



THE 5 Senses
SMELL
On average the human brain can detect between 2000 and 4000 different smells. Someone with a highly developed sense of smell can recognize as many as 10,000 odors. The sense of smell "wears off" more quickly than any other sense. The brain becomes accustomed to the new smell, and usually stops registering it within 30 seconds after it is first detected.
Olfactory bulb
On the roof of each nasal cavity is a thumbnail-size patch of lining called the olfactory epithelium.
Olfactory bulb
Olfactory tract
Bowman's gland
Nerve fibers
Olfactory sensory cell
Olfactory epithelium
Mucus layer
Cilia
The olfactory epithelium consists of millions of olfactory sensory cells. Each of these cells has tiny hairs (cilia) projecting downward into a layer of mucus produced by Bowman's glands.
Odor molecules are dissolved in the mucus, which stimulates receptor sites on the cilia. This generates nerve signals that move upward through the nerve fibers to the olfactory bulb, where they are sorted before being sent to the brain for interpretation.
85%
37%
28%
AGE 18
AGE 62
AGE 80
% Smell Capability
The sense of smell is strongest at birth, and diminishes as we age.

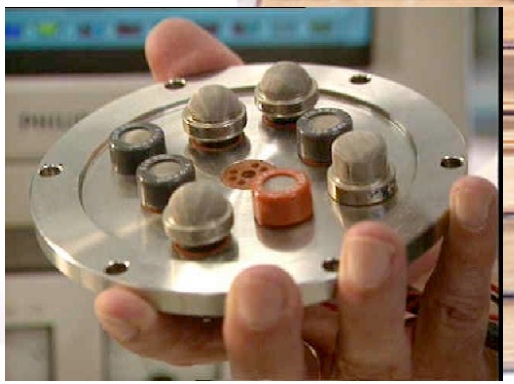


TECHNIQUES TO ANALYZE ODORS

- Chemosensors
- Gas chromatography
- Electronic nose


ELECTRONIC NOSE CONCEPT
BIOLOGICAL NOSE
To Limbic system and Cortex
Glumeruli
Olfactory Bulb
Cribiform Plate (Bone)
Olfactory Axons
Olfactory Epithelium
Olfactory Receptors
Cerebral Cortex
Olfactory Cortex
Nasal Cavity
ELECTRONICAL NOSE
SENSORY SYSTEM
ELECTRONIC SYSTEM
Timing Reference
Frequency Counter
Interface to Computer
NEURAL NETWORKS

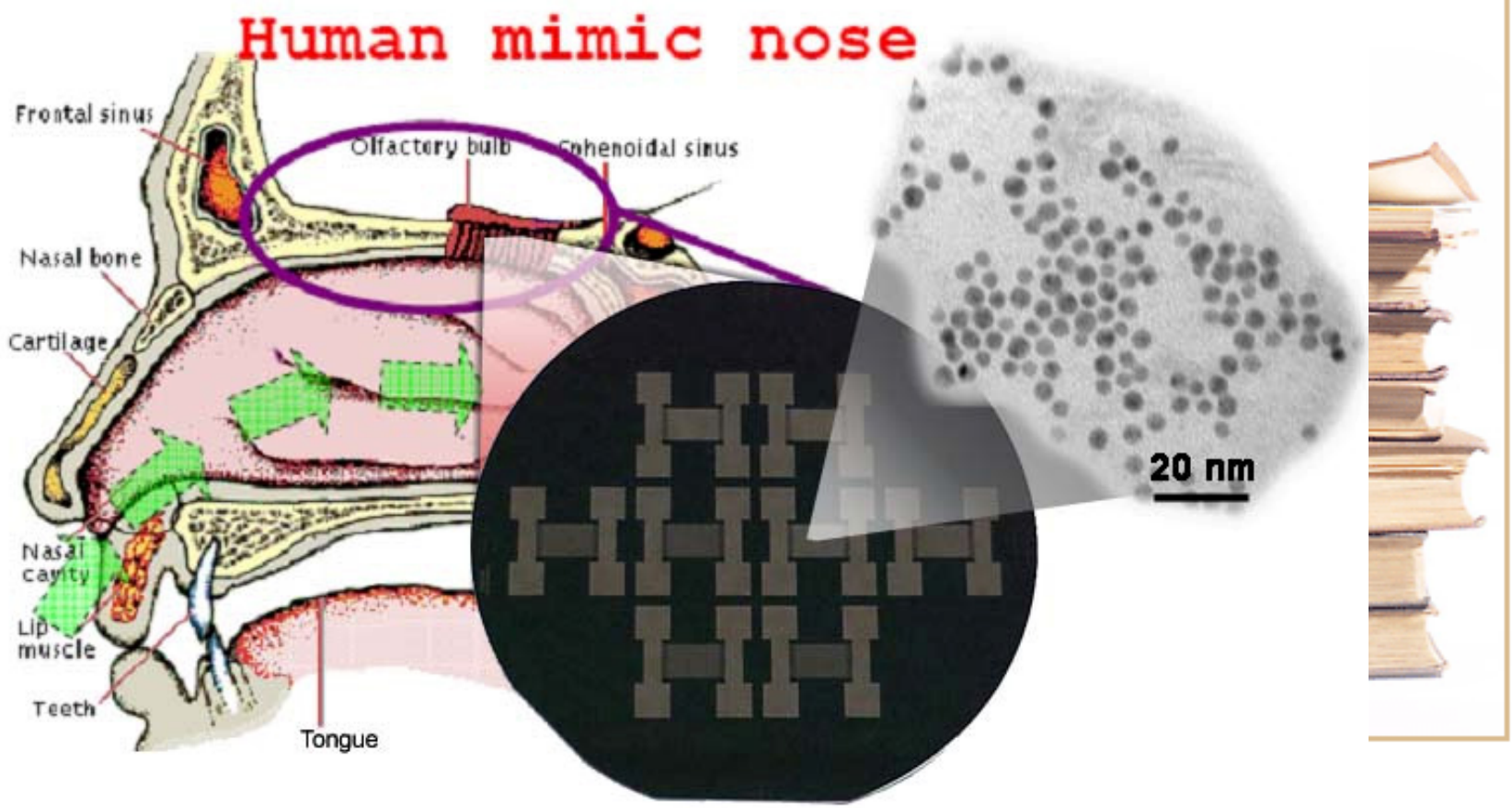
Electronic noses

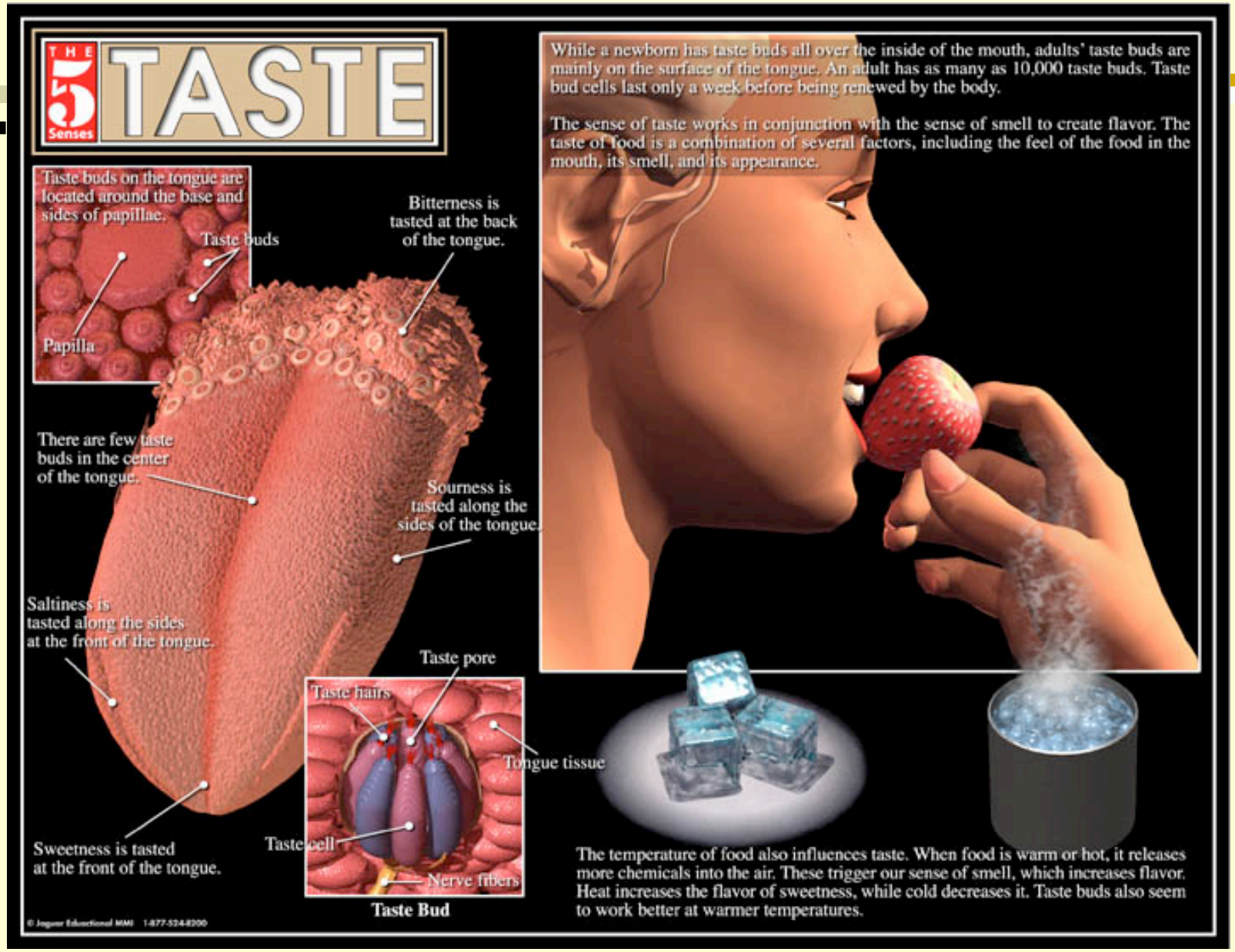


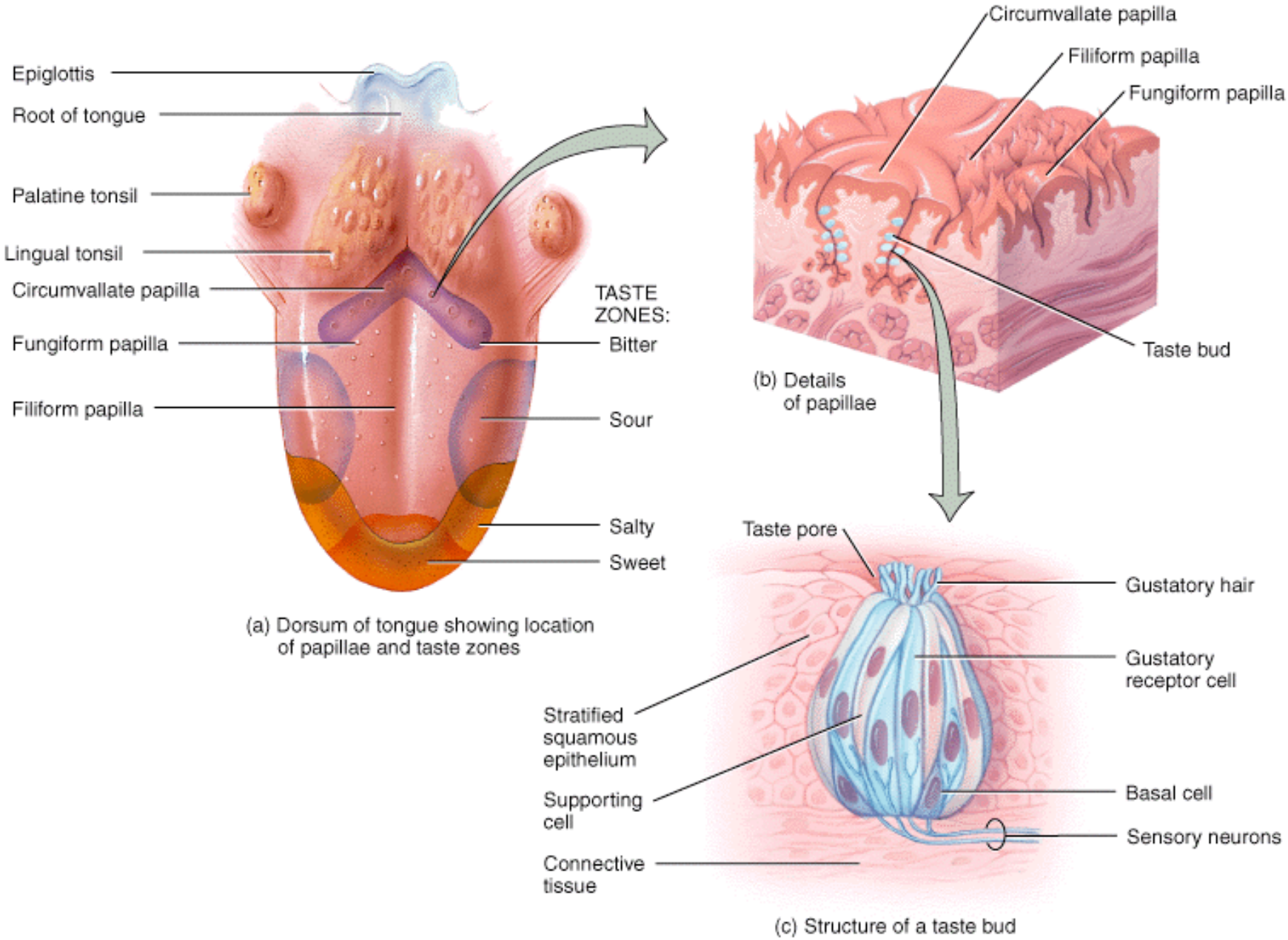
Electronic noses - Applications

- **in R&D laboratories for:Formulation or reformulation of products, Benchmarking with competitive products, Shelf life and stability studies, Selection of raw materials, Packaging interaction effects, Simplification of consumer preference test.**
- **in Quality Control laboratories for at line quality control such as: Conformity of raw materials, intermediate and final products, Batch to batch consistency, Detection of contamination, spoilage, adulteration, Origin or vendor selection, Monitoring of storage conditions.**
- **In process and production departments for: Managing raw material variability, Comparison with a reference product, Measurement and comparison of the effects of manufacturing process on products, Following-up cleaning in place process efficiency, Scale-up monitoring, Cleaning in place monitoring.**

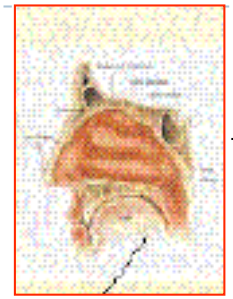
- http://www.youtube.com/watch?v=67KZMoB5QHs&NR=1
- http://www.youtube.com/watch?v=9XZH_T6O-OQ&feature=player_embedded#at=101
- http://www.youtube.com/watch?v=aX85QTqLX9I&feature=related

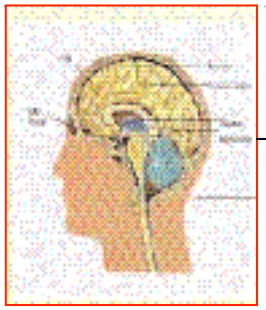


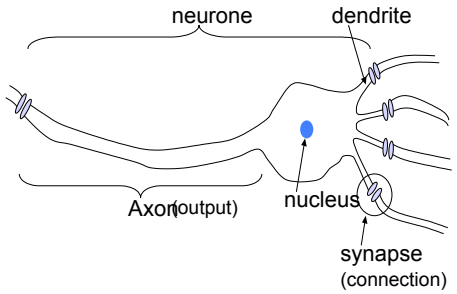

THE 5 Senses
TASTE
While a newborn has taste buds all over the inside of the mouth, adults' taste buds are mainly on the surface of the tongue. An adult has as many as 10,000 taste buds. Taste bud cells last only a week before being renewed by the body.
The sense of taste works in conjunction with the sense of smell to create flavor. The taste of food is a combination of several factors, including the feel of the food in the mouth, its smell, and its appearance.
Taste buds on the tongue are located around the base and sides of papillae.
Taste buds
Papilla
Bitterness is tasted at the back of the tongue.
There are few taste buds in the center of the tongue.
Sourness is tasted along the sides of the tongue.
Saltiness is tasted along the sides at the front of the tongue.
Sweetness is tasted at the front of the tongue.
Taste pore
Taste hairs
Tongue tissue
Taste cell
Nerve fibers
Taste Bud
The temperature of food also influences taste. When food is warm or hot, it releases more chemicals into the air. These trigger our sense of smell, which increases flavor. Heat increases the flavor of sweetness, while cold decreases it. Taste buds also seem to work better at warmer temperatures.
© Jaguar Educational MMI 1-877-524-8200



ELECTRONIC TONGUE







Lengua

Cerebro

Neuronas

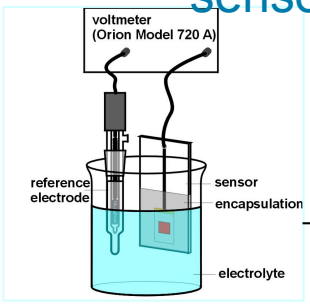
Adquisición

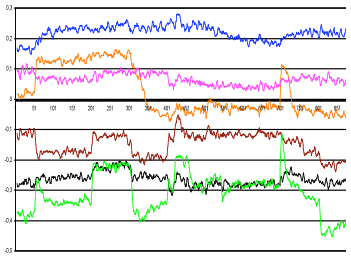
Tratamiento Datos

Comparación sabores

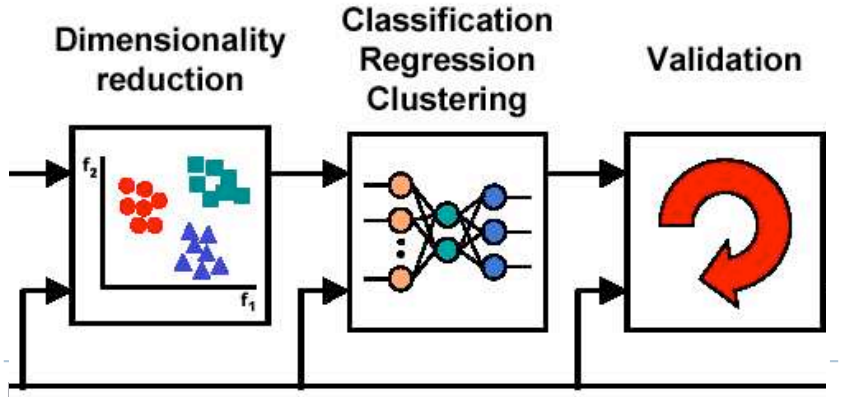
RESULTADOS

Respuesta sensores





Análisis Estadístico



http://www.markstechnologynews.com/2008/08/electronic-tongue-taste-of-our-cyborg.html

Electronic Tongue: A Taste Of Our Cyborg Future?

- European scientists have developed an advanced electronic tongue that is so sensitive, it can detect the grape variety and vintage of your favourite wine. All at the press of a button.

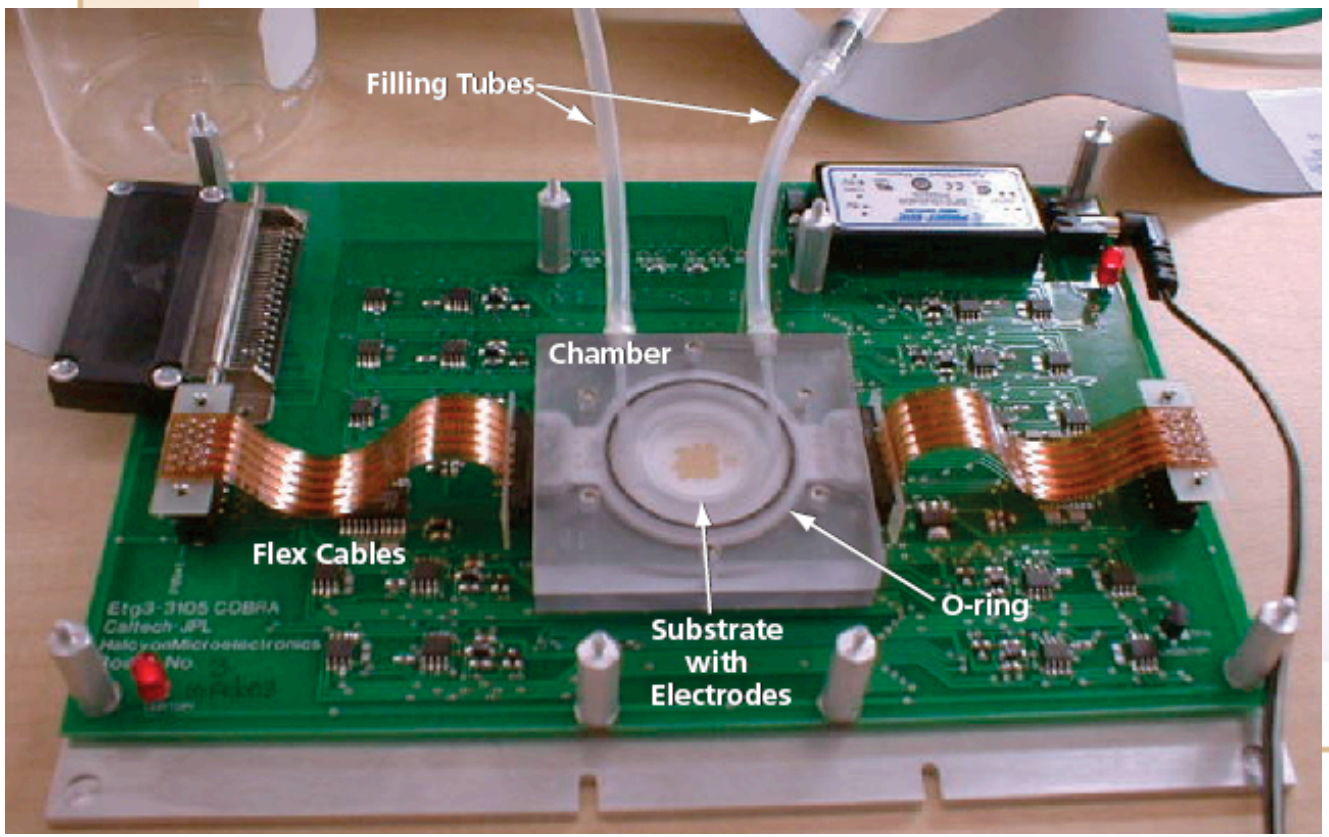
- The electronic tongue is designed for quality control purposes in the wine business and can be used in the field, providing a faster and more accurate means of testing. Usually a sample would be sent away to a central laboratory for testing, slowing down wine production.
- Made up of six sensors, the electronic tongue can detect substances such as sugar, acid and alcohol present in a sample. With this information, the device can determine a wine's age and variety which may also prove useful in detecting vintage fraud.
- The device is portable and cheap to manufacture which definitely works in its favor. The question is, will we start seeing this kind of tech implanted directly into our own tongues in the future? I guess neural pathways would need to be developed and in a much more sophisticated way than just **sticking wires into a monkey's skull**. I'll keep you posted.

http://www.techbriefs.com/component/content/article/2298

- Electronic tongues were described in two prior NASA Tech Briefs articles: "Electronic Tongue for Quantitation of Contaminants in Water" (npo-30601), Vol. 28, No. 2 (February 2004), page 31; and "Electronic Tongue Containing Redox and Conductivity Sensors" (NPO- 30862), Vol. 31, No. 8 (August 2007), page 58. Electronic tongues can be used for a variety of purposes, including evaluating water quality, analyzing biochemicals, analyzing biofilms, and measuring electrical conductivities of soils.

- http://www.techbriefs.com/component/content/article/2298

- http://weewave.mer.utexas.edu/MED_files/MED_research/MEMS_chem_snsr/beads/bead_sensor.html



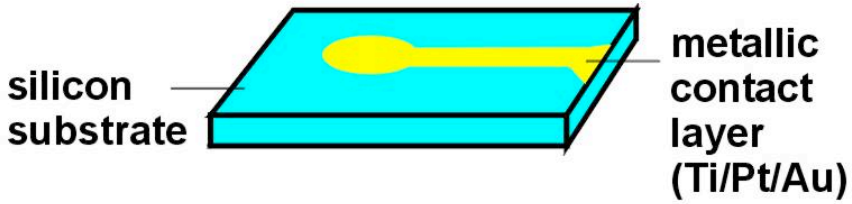
Range of applications

Electronic Tongues have several applications in various industrial areas: the pharmaceutical industry, food and beverage sector, etc. It can be used to:

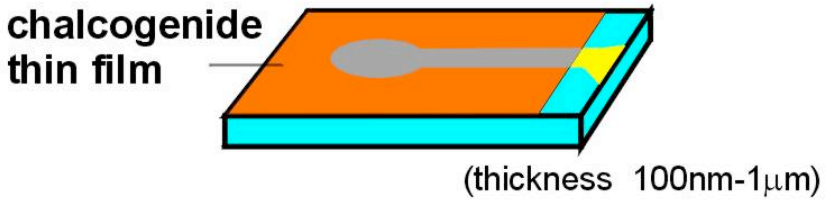
- analyze flavor ageing in beverages (for instance fruit juice, alcoholic or non alcoholic drinks, flavored milks…)
- quantify bitterness or "spicy level" of drinks or dissolved compounds (e.g. bitterness measurement and prediction of teas)
- quantify taste masking efficiency of formulations (tablets, syrups, powders, capsules, lozenges…)
- analyze medicines stability in terms of taste
- benchmark target products.

POTENTIOMETRIC MEASUREMENTS

Lift-off



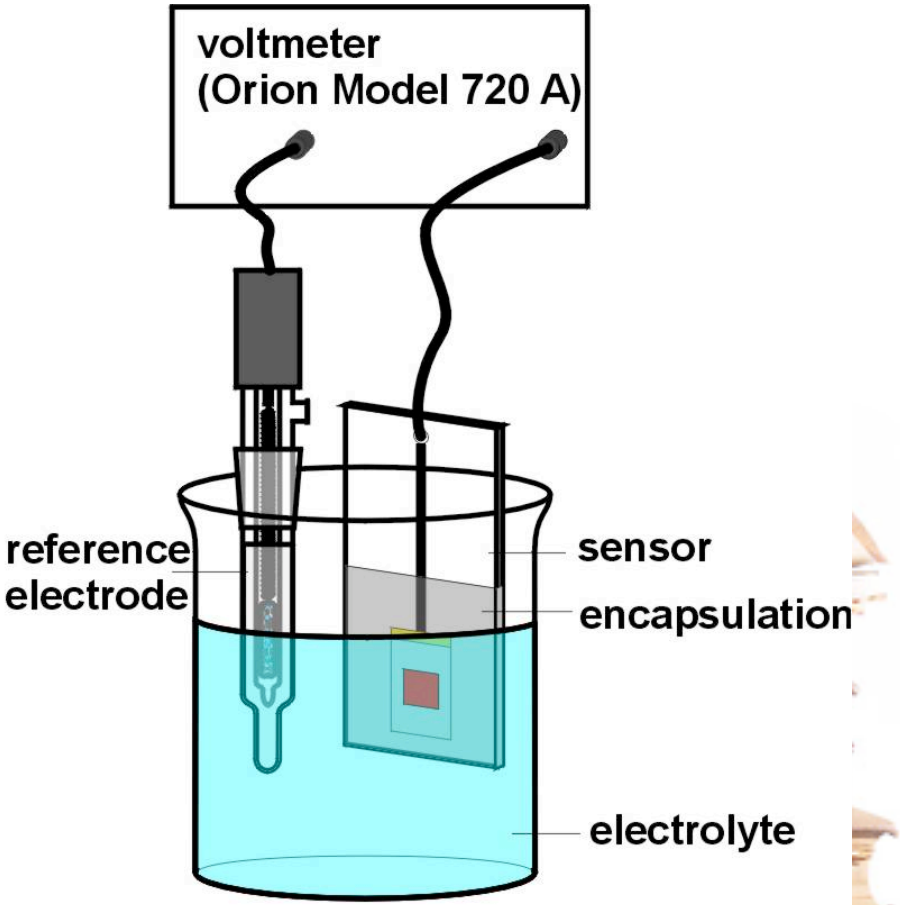
PLD



Encapsulation, Bonding

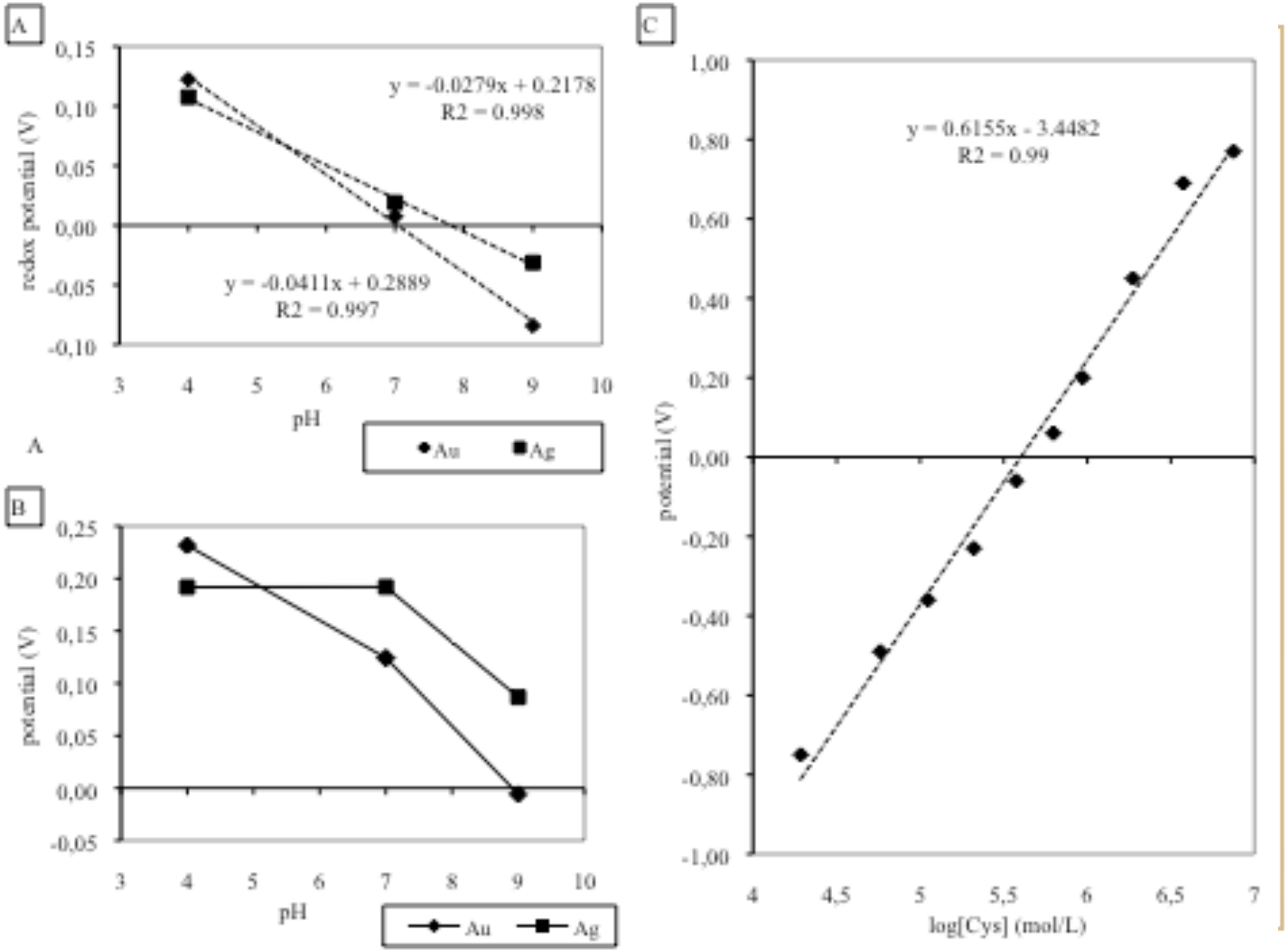
Materials

Ag-As-S, Cu-Ag-Se-Te-As,
Pb-Ag-I-As-S, Cd-Ag-I-As-S, Tl-Ag-I-As-S

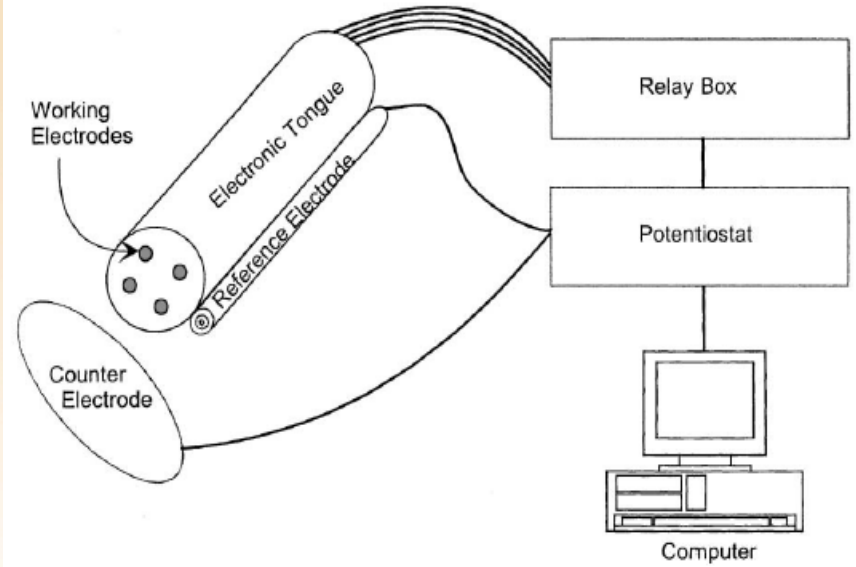


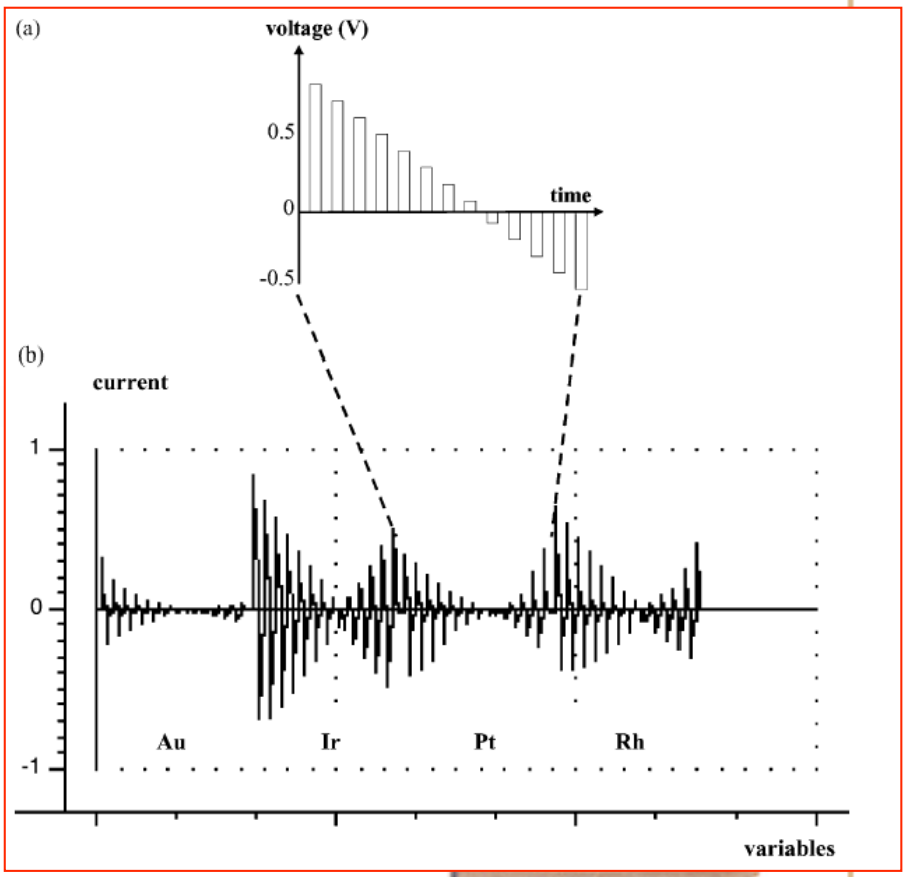
- Chemistry Department, St. Petersburg University, Russia

- Department of Electronic Engeneering, University of Roma, Italy


A
redox potential (V)
y = -0.0279x + 0.2178
R2 = 0.998
y = -0.0411x + 0.2889
R2 = 0.997
pH
Au
Ag
A
B
potential (V)
pH
Au
Ag
C
potential (V)
y = 0.6155x - 3.4482
R2 = 0.99
log[Cys] (mol/L)

VOLTAMETRIC TONGUE

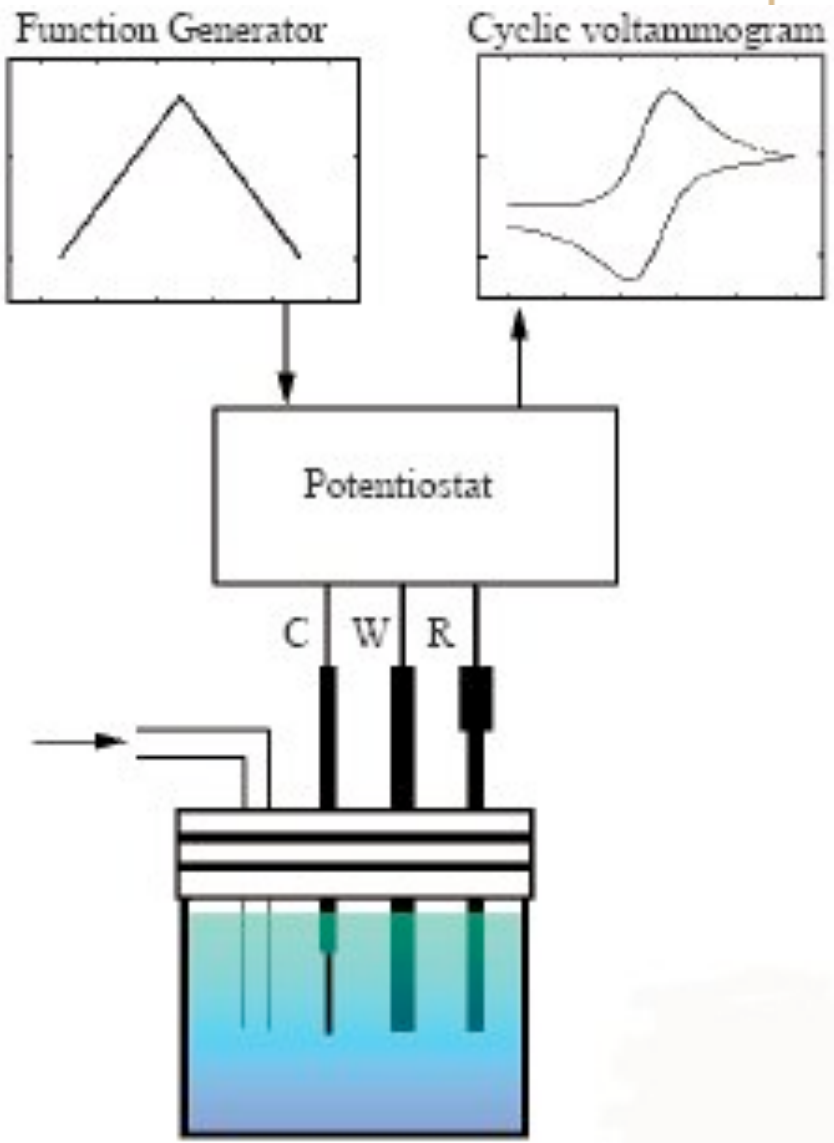




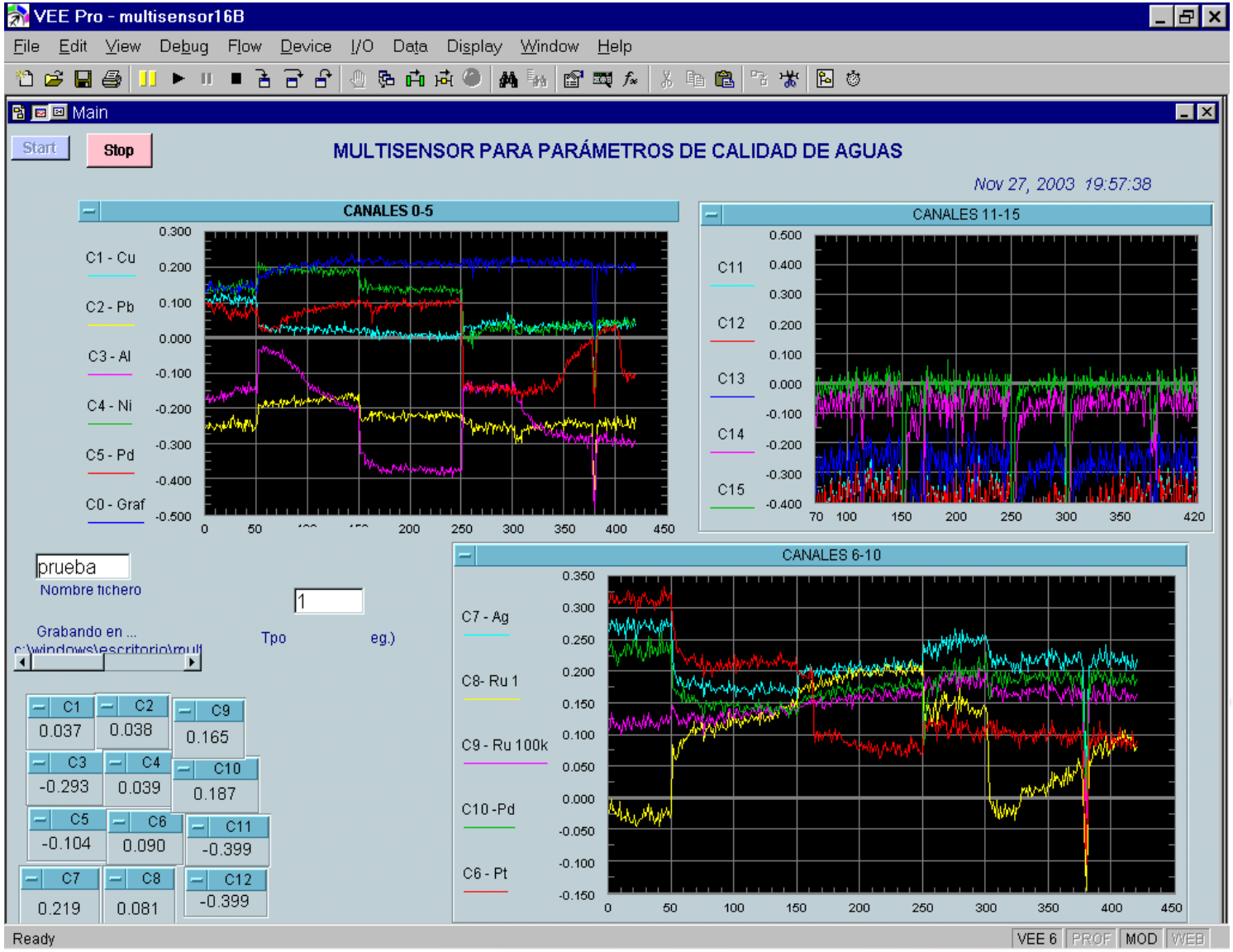
- *The Swedish Sensor Center. Linköping University, Sweden*
- *Center for Autonomous Sensor System. Örebro University, Sweden*

Cyclic voltammetry (CV) is a reversible LSV measurement which scans electric potential turned to reverse direction after reaching final potential and scan back to initial potential. In CV, the reversibility of the product produced in forward scanning can be analyzed by backward scanning. Because of this characteristic, CV has been applied widely. If a CV conducts with potential wave form as shown in right, then we can study the substance characteristic as

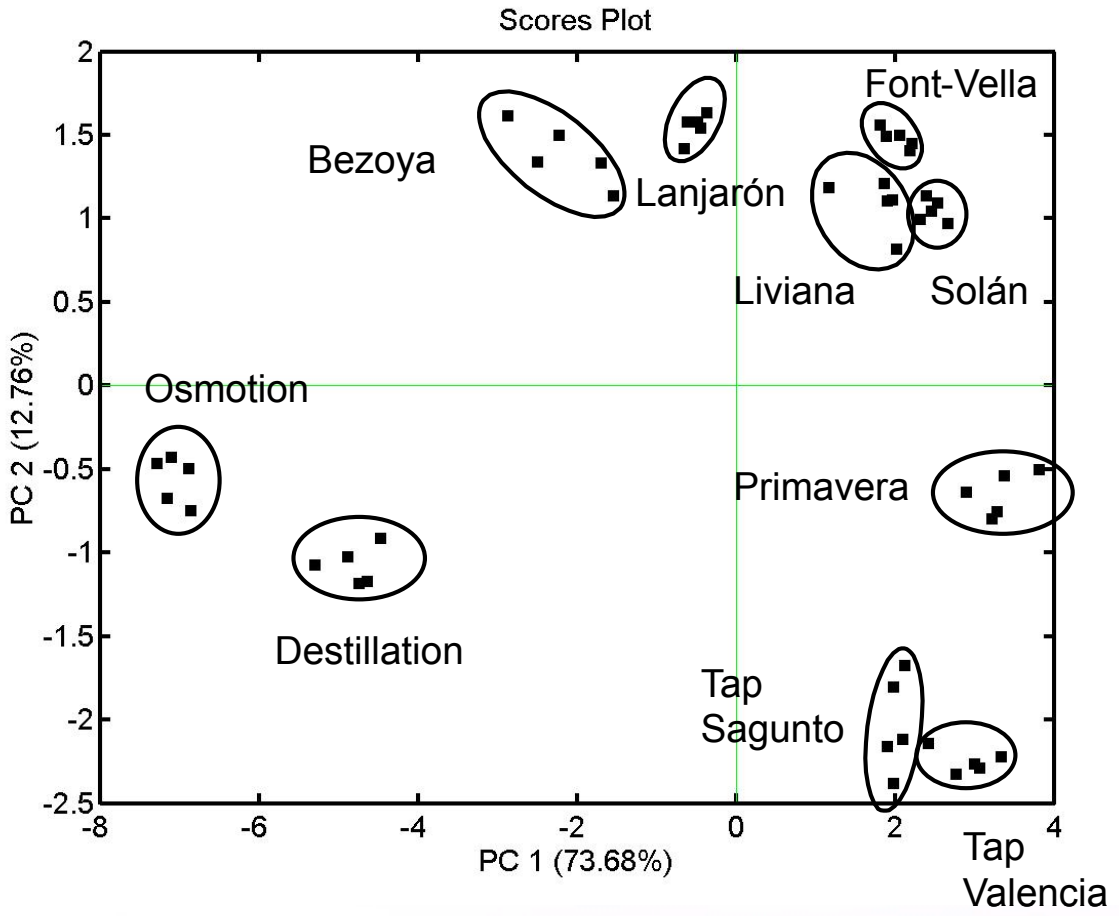
Stability in oxidized and reduced forms
Molecular adsorption in redox process
Measurements of kinetic rate constants
Study of reaction mechanism
Reversibility of electrochemical reaction
Standard redox potential, $E_o=(E_{pa}+E_{pc})/2$
Electron transfer number, $\Delta E=E_{pa}-E_{pc}= 58/n$
*n: electron transfer number per mole



OBTAINED DATA

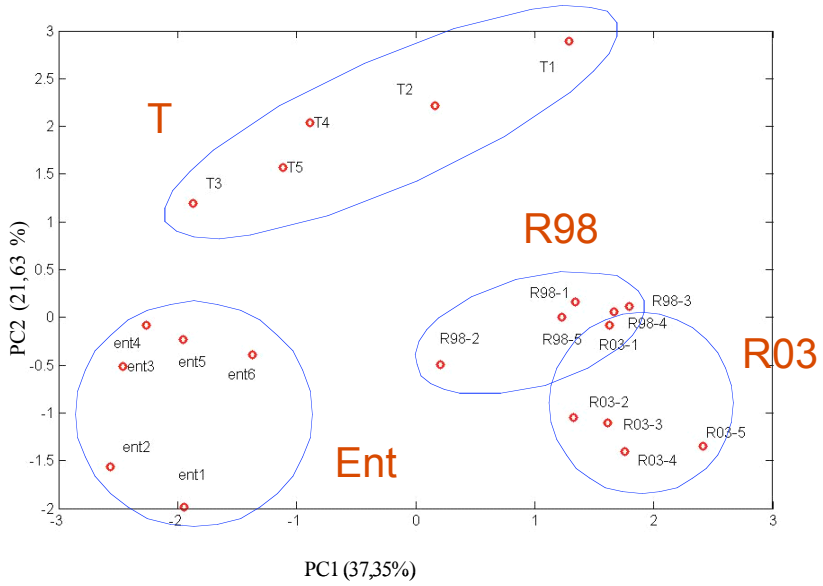


WATER CLASSIFICATION



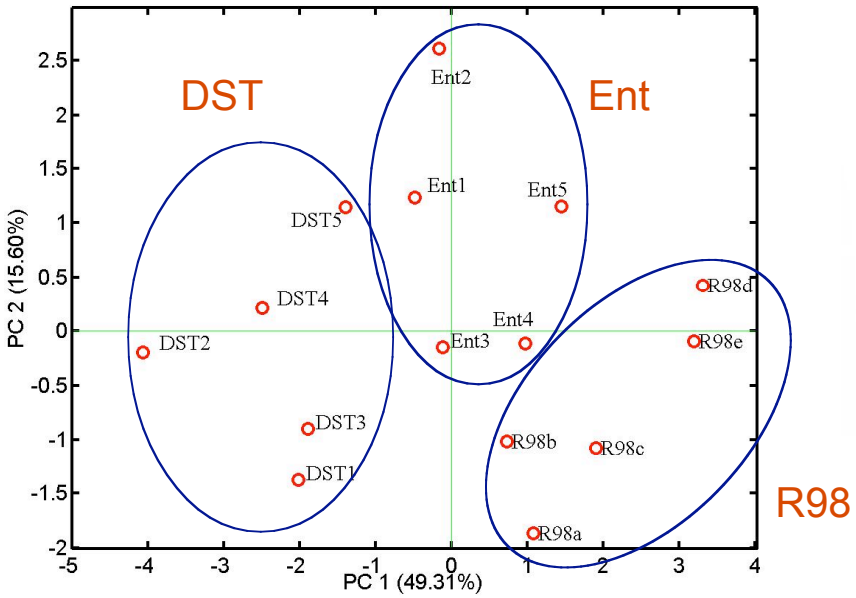
Classification of commercial wines

Análisis PCA de las medidas con electrodos individuales



Ent: *Enterizo*, T: *Don Simón*
R98: *Rioja 1998;* R03*: Rioja 2003*

Discriminación de las medidas con multielectrodo



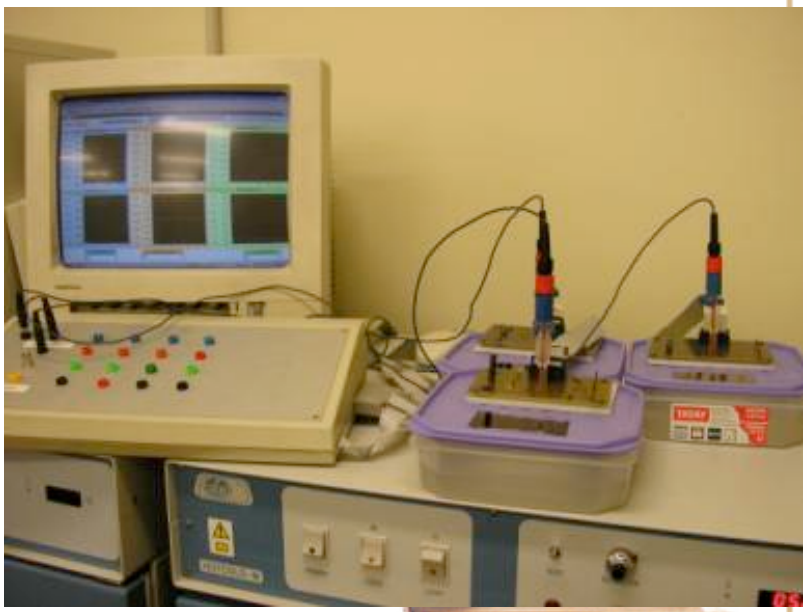
Ent: *Enterizo*, DST: *Don Simón*
R98: *Rioja 1998*

DATOS OBTENIDOS POR INVESTIGADORES DEL INSTITUTO REMOTE - UPV

Electronic tongues on solid foods

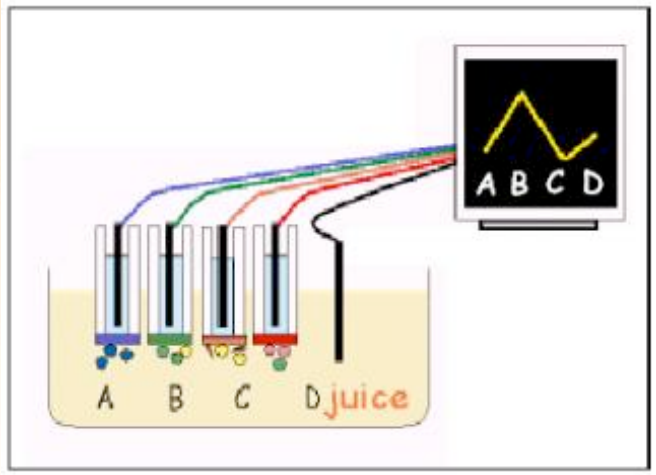
- Sistema Triplicado de

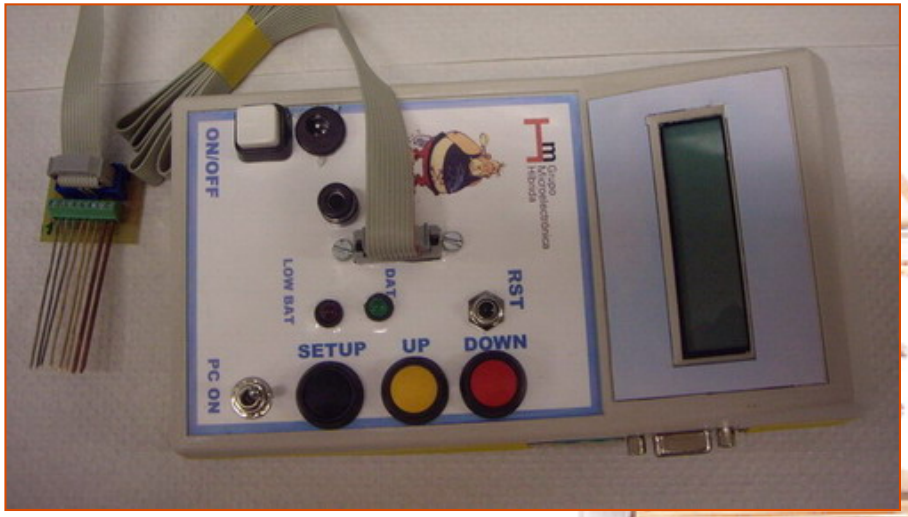
- Pescado triturado y repartido en 3 cajas
- En cada caja: 3 electrodos de oro y 3 electrodos de plata
- Medidas en modo discreto
- 3 medidas diarías en un total de 9 días no consecutivos
- Análisis Multivariante (PCA, FuzzyART, Redes Neuronales, etc.)
- Experiencias Bioquímicas
- Correlación entre ambos tipos de medidas



Se incluyó una placa para el multiplexado de la señal de tres a uno

Sistema electrónico que por medio de múltiples sensores no específicos puede realizar un análisis cualitativo con muestras de naturaleza líquida.

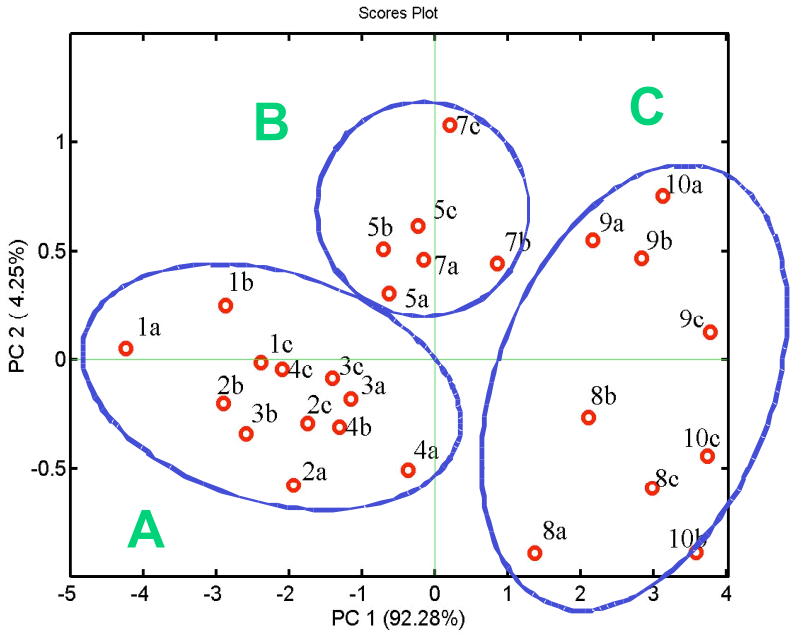


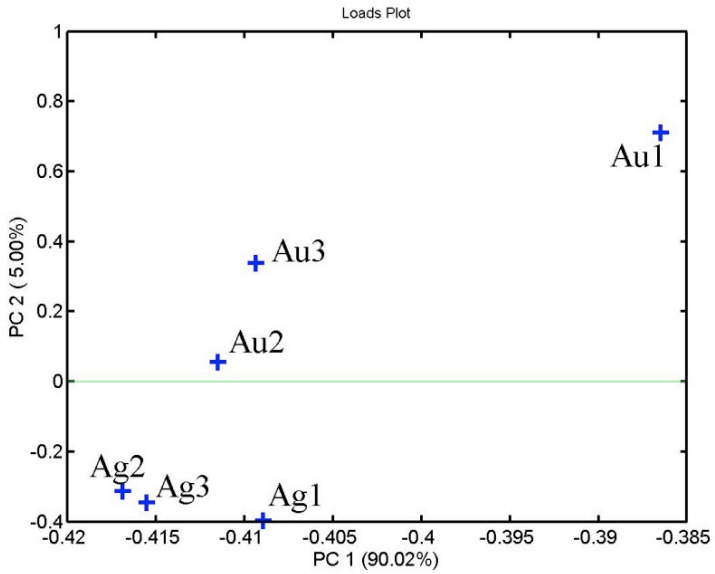


Información característica: "huella electrónica" de la muestra

Medidas con Electrodos Punzantes. Definitiva

- Análisis PCA Total 27 medidas (3 medidas/día x 9 días





3 Grupos:

A: días 1, 2, 3 y 4
B: días 5 y 7
C: días 8, 9 y 10

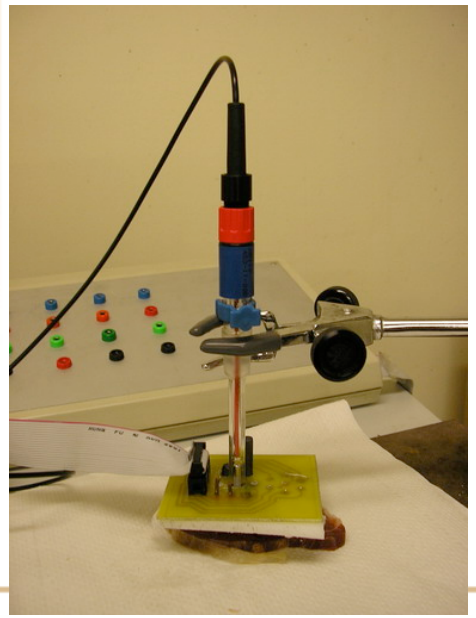
Electrodos de Ag más homogéneos que Au

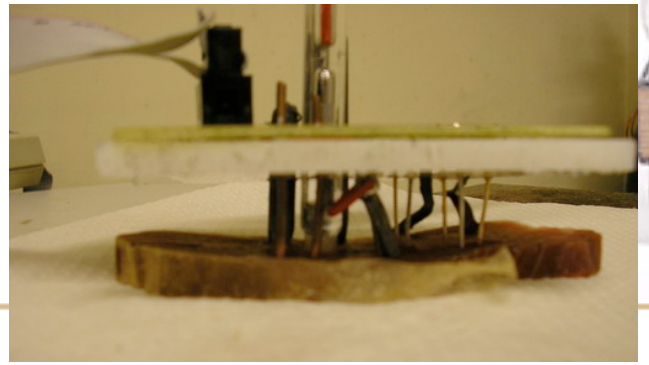
STUDIES WITH MEAT

1) Detección del proceso de deterioro carne de lomo fresco de cerdo.
2) Discriminación carne curada de cerdo con distintos tipos de sales

Electrodos: Sistema de múltiples electrodos (10) punzantes

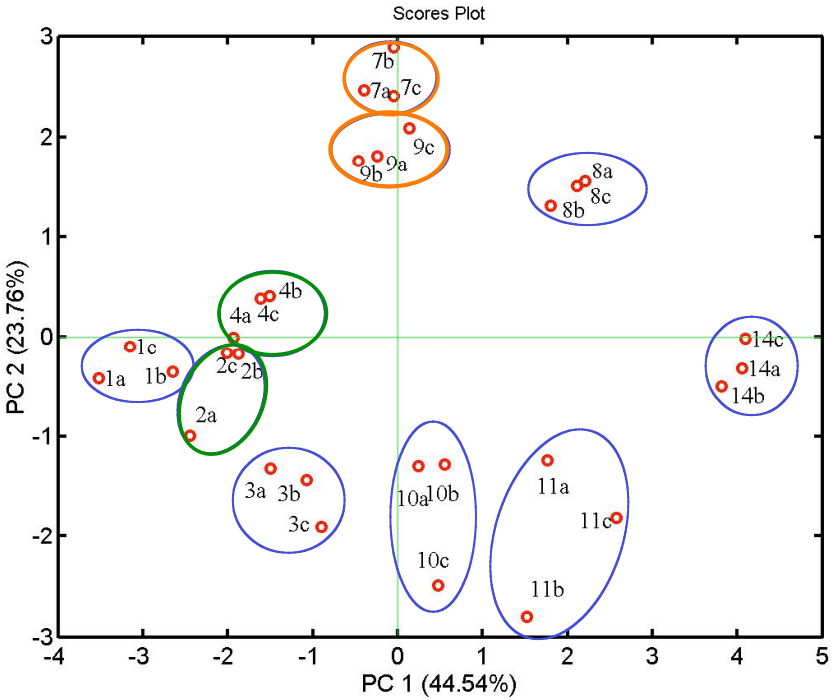
Nº Electrodos	Material
2	Cobre
2	Oro
2	Plata
2	Plomo
1	Carbón
1	Zinc

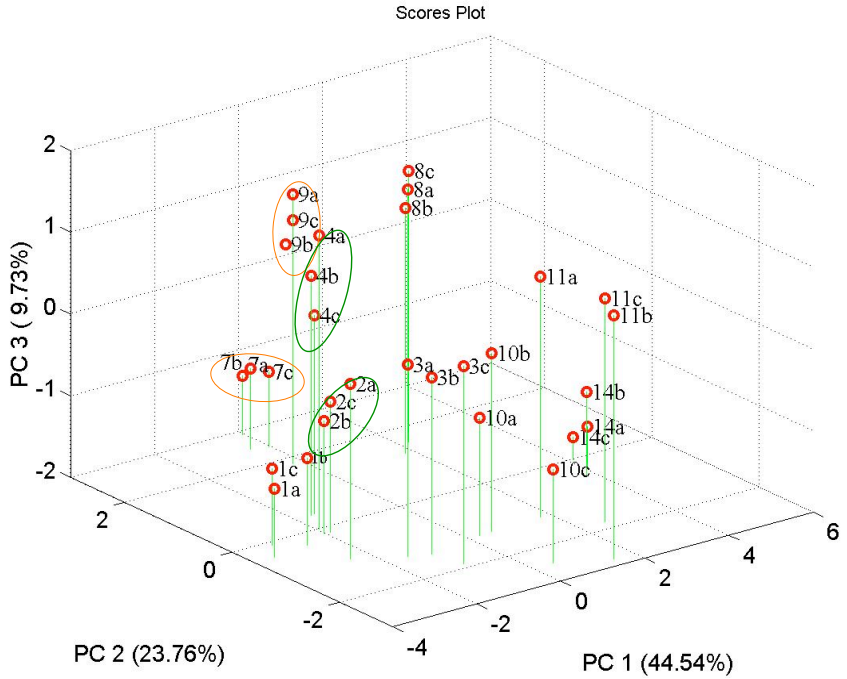




MEAT FRESHNESS

- Resultados. Análisis PCA

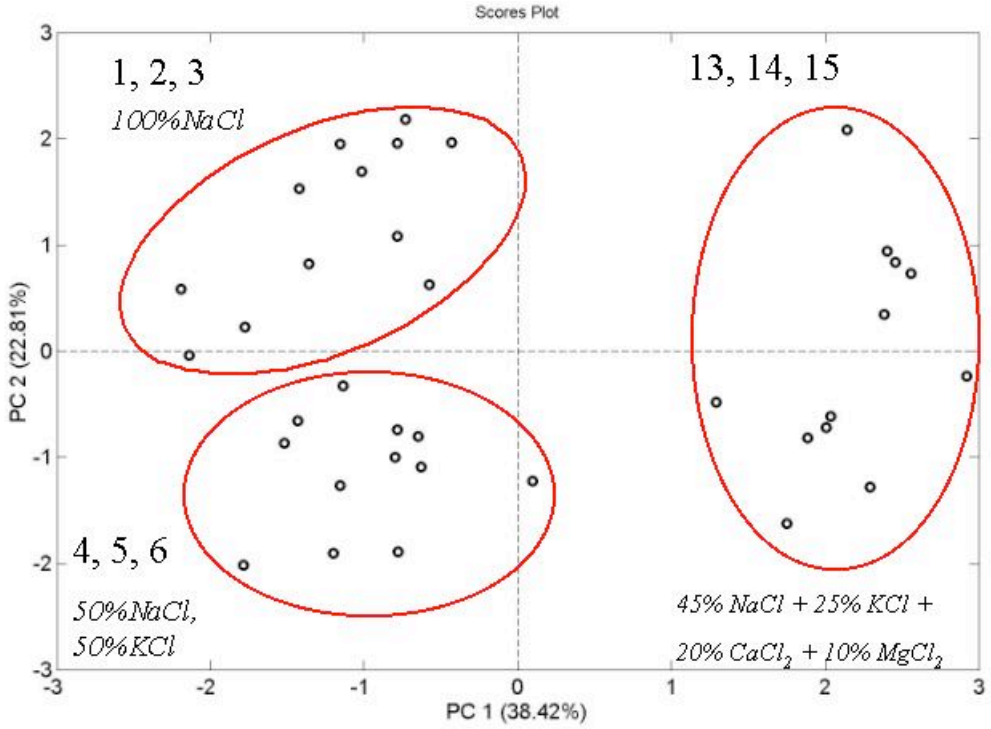




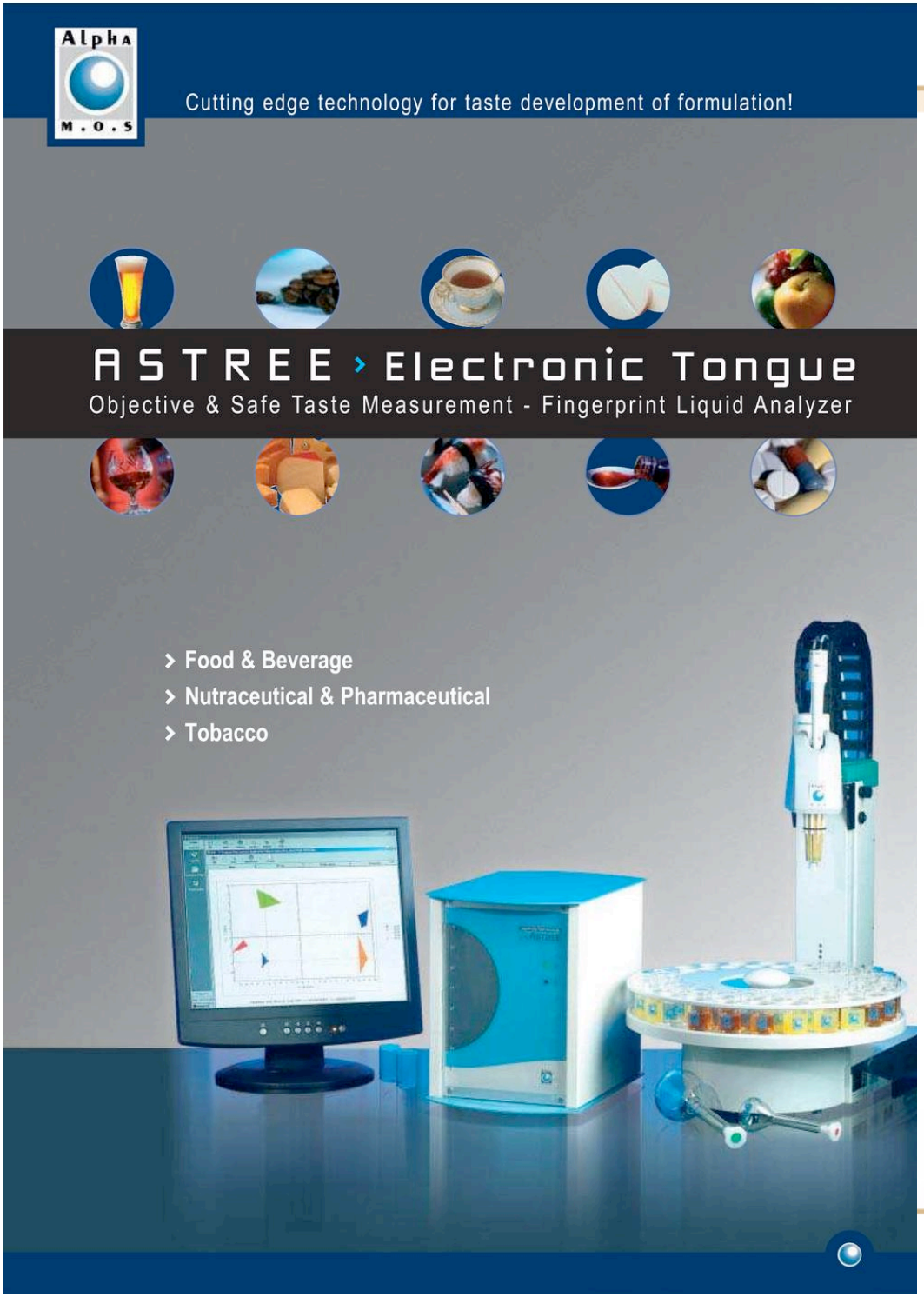
Agrupación por días
PC1 proporcional tiempo

Gráfica tridimensional mejor discriminación días 7 y 9 y días 2 y 4

Low sodium pork loin



- Discriminación por grupos de muestras.
- Mejor discriminación de las muestras con Ca y Mg que K respecto con Na.



- http://pdf.directindustry.com/pdf/alpha-mos/electronic-tongue/39513-23644.html

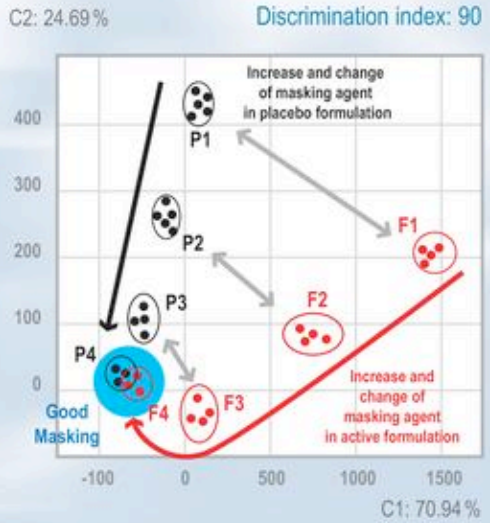
ASTREE

› the key tool for taste assessment

Taste Masking

- Optimize the taste masking efficiency of active (NCE / Nutraceutical) formulation even before safety assessment study
- Assess the impact on taste of every ingredient
- Measure the bitterness intensity and improve your formulation design / selection
- Enlarge your portfolio of choice of ingredients without a systematic use of sensory panel

› › Improve your formulation for better consumer likings

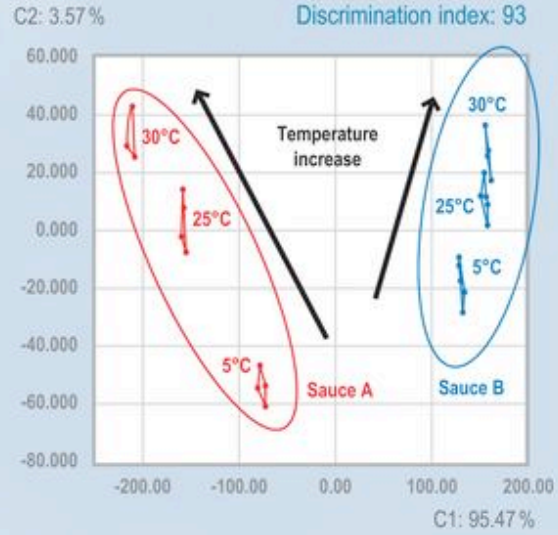


Comparison of formulation with active drug (F) and the corresponding formulation without active substance (placebo P). When the distance is reduced, the taste masking has been improved.

Shelf Life

- Analyze taste evolution and stability of oral formulations according to various storage conditions, time or packaging

Efficiently compare the stability profile of various formulations under stress or natural ageing



Comparison of taste evolution of 2 sauces A and B after 30 days of storage at three various temperatures: 5°C, 25°C and 30°C.
Sauce B is more stable than sauce A.

Taste Comparison

Compare various products:

- new and original formulations
- yours and competitors
- brand products & generics
- products from various origins …

After comparing 3 marketed products, the formulation candidate selected will be the one closer to the more palatable competitive product.

Benchmark your competitors
Monitor quality of your suppliers
Compare your processes

What can the Electronic Tongue do for you?

- Develop products with consumer oriented taste
- Avoid consumer complains & re-development process
- Multiply taste screening & test more formulation candidates
- Build internal organoleptic expertise
- Save time and money by speeding up product development

Food & Beverages

- Mineral water
- Soda - fruit & vegetable juice
- Coffee - tea - chocolate
- Dairy products & milk
- Beer - wine - liquor
- Freezed dried soup - tomato sauce
- Salad dressing - vinegar …

Nutraceuticals & Pharmaceuticals

- Tablets (coated, effervescent and dispersible …)
- Lozenges
- Microgranules
- Powder
- Hard or Soft capsules
- Oral liquid solutions & syrups …

Saltiness, Sweetness, Sourness, Bitterness, Umami
Pungency, Spiciness, Astringency, Kukomi ...

- Taste masking efficiency
- Discrimination of origins
- Product stability testing
- Packaging migration monitoring
- Taste matching of gold reference
- Comparison with other products
- Bitterness masking efficiency
- Shelf life & ageing
- Placebo taste matching
- Quantification of additives & drugs
- Comparison with competitive products

Test products
- even non GRAS*
*Generally Recognized As Safe

21 CFR Part 11 Compliant

Analyze the flavor and taste of:

- raw materials
- standard or new formulations
- pilot, intermediate and final products

Electronic Tongue

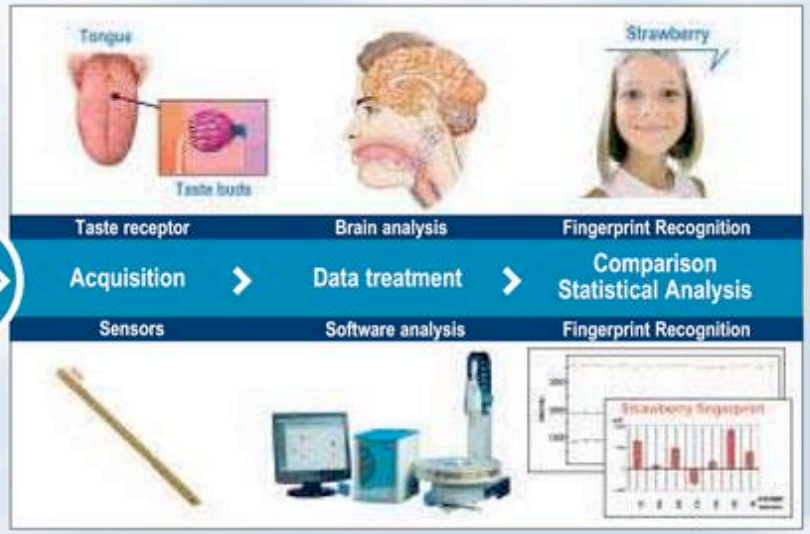
Working principle

Like the human tongue, the ASTREE Electronic Tongue performs a global analysis (fingerprint) of a complex dissolved organic or inorganic compounds mixture.

The sensor head (7 cross selective sensors) dips into the liquid sample to be tested.

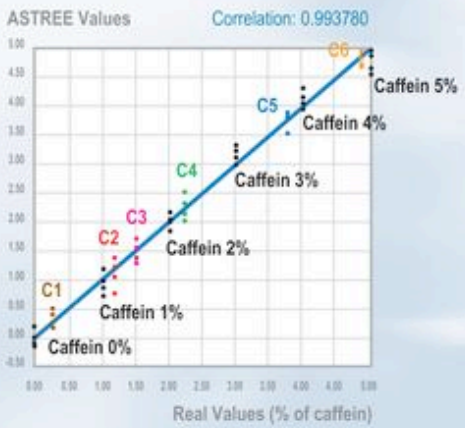
Manipulation are automatically executed thanks to the autosampler. Record of the sensor output is performed within 2 minutes and then analyzed by a complete chemometric software using multivariate statistics.

ASTREE Electronic Tongue has for all basic tastes a similar or better detection threshold than the Human Tongue.



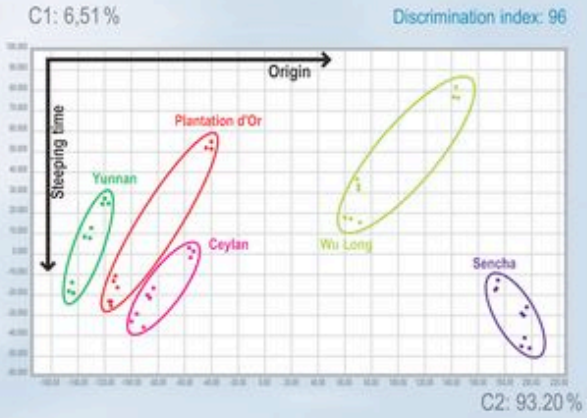
More results

Caffein level prediction in coffees



After building a predictive model (black spots), ASTREE can determine caffein concentration in various coffees (C1 to C6) with a very good reproducibility.

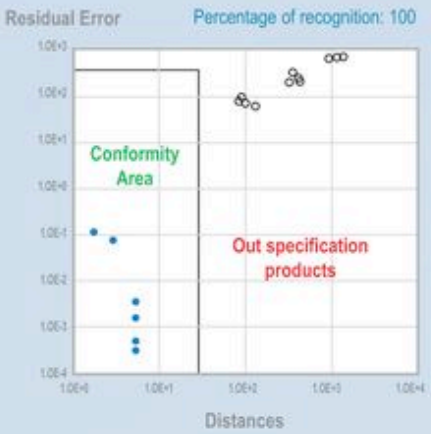
Discrimination of tea (origin & steeping time)



- Yunnan (Black tea from China)
- Plantation d'Or (Black tea from China)
- Ceylan (Black tea from Sri Lanka)
- Wu Long (Tea from Taiwan)
- Sencha (Green tea from Japan)

3 steeping times
- 4 minutes
- 6 minutes
- 8 minutes

Beer freshness discrimination



After a training phase, the ASTREE is able to discriminate fresh beers from aged beers (from 3 to 5 months).

Main system specifications

- **Liquid Autosampler** 1 with a carroussel capacity: 16 beakers (80 mL) or 48 beakers (20 mL), a programmable sample agitation, a robotic sensor head and individual connections for each sensor
- **Astree Electrochemical Sensor Array** 2 including one reference electrode (Ag/AgCl) and 7 liquid cross selective sensors with 2 specific sets (Food & Beverage or Pharmaceutical industries).
- **Astree Electronic Tongue Unit** 3 with sensor board (1 to 28 channels available), acquisition board (acquisition frequency 10 Hz), main board for data acquisition and power supply card (110-120 VAC, 220-240 VAC)
  - External Input / output: RS232 connections
  - Electronic Unit Dimensions (L x W x H): 26 x 30 x 100 cm - 66 x 76 x 254 inch
  - Electronic Unit Weight: 25 kg
- **Astree Software V3.0** 4 with autosampler and acquisition control, a complete multivariate statistics package (PCA, DFA, SIMCA, PLS) and various maintenance tools as automatic system diagnostic & sensor diagnostic

Multi-language software

- **Consumable Packages included: start-up kit** (beakers, diagnostic solutions), calibration solutions, **complete maintenance kit** (electrolyte, rinsing & diagnostic solutions, spare sensor set), **accessory kit**

- **Analysis features:**
  - Environmental Conditions: operating temperature constant +/ 3°C
  - Analysis Time 200s including:
    - Sensor acquisition: 120s
    - Rinsing time: 10s
  - Precision: RSD ≤ 3%
  - Sensibility and Accuracy: sensors sensitive and partially selective to chemical species - ionic and neutral.

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THANK YOU FOR YOUR ATTENTION